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Abstract

processing focus / representing contrast

by

Morwenna Hoeks

This dissertation aims to show how existing behavioral evidence regarding the processing of focus can be brought more in line with an alternative-based understanding of focus as proposed in theoretical semantics, without losing sight of the way general comprehension pressures may shape its interpretation. Throughout, I argue that this is possible by studying how the mental representations involved in the processing of focus are incrementally constructed during sentence comprehension. Reading measures obtained in a series of Maze experiments show that comprehenders arrive at a final interpretation of a focus by combining multiple sources of evidence, including lexical, conceptual and world-knowledge, as well as fine-grained linguistic representations that guide the incremental interpretation of focus independently from such general knowledge. These findings allow for a unified understanding of the inconsistent results previously found in the reading of focus, while also explaining how alternatives and discourse context are involved in the prioritization and anticipation of foci.

Experiments 1-4 show, first, that the comprehension of focus generally induces a processing cost because reading times on foci are longer than on non-foci. It then shows that this cost is reduced when contrastive alternatives to the focus are mentioned in the preceding context, suggesting that the representation of contrastive alternatives is indeed involved in the comprehension of focus. The presence of focus marking induces a cost that is separable from a cost of interpreting newly introduced information, and that the presence of alterna-

tives provides a reading benefit that is separable from a benefit due to semantic priming. Together, these findings suggest that contrastive alternatives must somehow be involved in the processing of focus, and that its cost cannot be explained in terms of a general cost for new material.

Experiments 5-7 investigate how discourse context is used to assign a focus structure to a sentence in incremental sentence comprehension. It shows that the presence of contrasting material in the context is used by comprehenders to assign focus marking to subsequent sentences, suggesting that representations of contextual contrasts are utilized to anticipate the location of an upcoming focus. Again, results indicate that these behavioral effects of focus are separable from effects of newness or the predictability of upcoming material in general. This suggests that it is crucially the fact that comprehenders encode abstract representations of contextual contrasts that gives rise to these behavioral effects of focus, not the presumed communicative importance of foci or unpredictability alone.

Finally, experiments 8-10 study what information comprehenders rely on in constructing an alternative set to a focus. This chapter again provides evidence for the claim that abstract linguistic representations of the discourse context are used to either rule in or rule out potential members of the alternative set to a focus. It shows that the deployment of these types of representations is fast, and independent from the use of general conceptual knowledge or the use of domain-general mechanisms such as semantic priming. I thus propose that comprehenders rapidly revisit semantic representations of the discourse context in constructing the alternative set to a focus.

to Lupos

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Chapter 1

Introduction

This dissertation is about the incremental interpretation of discourse. It is about the way in which human comprehenders derive meaning from the words they read or hear. Crucially, successful language comprehension involves not just the interpretation of those words themselves, but it also involves reasoning about things that have not been said out loud. For instance, in order to understand the message a sentence conveys comprehenders sometimes need to consider what expressions contrast with, and could substitute for, some expression in a sentence. The example in (1) intuitively contrasts the word *article* with expressions denoting other pieces of writing such as *book* or *monograph*. As such, a comprehender can come to understand this sentence to mean that Sarah did not read anything else besides an article.

(1) Sarah read only an [ARTICLE]_F. (she didn't read a book or a monograph...)

The need to consider such a contrast is signaled by varied linguistic devices, including *focus* (indicated throughout with []_F), which will be the center of interest in this dissertation. Focus is marked in English via intonation, or additionally by focus particles (e.g., *only*,

even, also,...) or focusing constructions (e.g., a cleft: *it was...that...*). In the example sentence in (1), the particle *only* and a falling pitch accent on *article* (annotated throughout with small caps) together indicate that a set of contrasting expressions to *article* needs to be considered. Similarly, in the example in (2a), since just the verb is accented, any actions that contrast with reading, such as writing or reviewing, are excluded. In (2b), the accent on *dinosaurs* gives rise to the inference that Sarah did not read any other articles besides one about dinosaurs.

- (2) a. Sarah only [READ]_F an article about dinosaurs. (...she did not write one)
b. Sarah only read an article about [DINOSAURS]_F. (...not an article about bats)

The interpretation of these sentences is directly dependent on the placement of focus, and this dependency is intuitively mediated by a notion of contrast. In the standard theory of focus, the meanings of focus particles refer to alternate versions of the sentence that differ solely in the position of focus, also referred to as *contrastive alternatives* (Jacobs 1983; Rooth 1985, 1992a). For *only*, all of these alternatives are negated, except for the one that is identical to the sentence in which it appears, thus yielding the inferences in (1) and (2a-b). Although the fact that alternatives are involved in the interpretation of foci is widely accepted in theoretical semantics, it is less clear what consequences this observation has for the way discourse is comprehended in real time. This dissertation therefore investigates how exactly comprehenders reason about such implicit contrastive alternatives during the incremental interpretation of foci.

This is not the first study of focus processing, however. Over the past several decades, psycholinguists have shown that focus marking has significant impacts on the way language is processed: The presence of focus marking has been shown to improve memory represen-

tations (Birch & Garnsey, 1995a; Fraundorf et al., 2010, 2013), to improve responses in change- and error-detection tasks (Bredart & Modolo, 1988; Sturt et al., 2004; Sanford & Sturt, 2002) to guide hearers' attention in auditory tasks (Cutler, 1976; Cutler & Fodor, 1979), to modulate responses in different priming tasks (Braun & Tagliapietra, 2010; Husband & Ferreira, 2016; Gotzner et al., 2016a), and to affect various measures obtained in reading (Birch & Rayner, 1997, 2010; Morris & Folk, 1998; Ward & Sturt, 2007; Benatar & Clifton, 2014; Lowder & Gordon, 2015). This multitude of behavioral effects has led some researchers to conclude that focus marking somehow has a special status in sentence comprehension, and that comprehenders generally allocate more resources—whether that is time, attention and/or memory—to the interpretation of foci (Cutler & Fodor, 1979; Bredart & Modolo, 1988; Sanford & Sturt, 2002; Benatar & Clifton, 2014; Lowder & Gordon, 2015).

One explanation for these effects that is prevalent in this literature is that foci generally constitute the most important information provided in a sentence, and that it is therefore part of efficient language processing to allocate more resources to it. For instance, one particular version of this explanation states that foci typically express information that is newly introduced in the discourse, and that comprehenders therefore spend more time and effort processing them (Benatar & Clifton, 2014). In this dissertation I argue specifically against such an understanding of these effects because it cannot explain why they still arise in contexts where foci do not provide new, unpredictable or otherwise important information.

The underlying problem with an understanding of focus in terms of importance is that it cannot account for the intuition that foci also evoke a contrast with alternatives—as is already illustrated above. A more useful understanding of focus is therefore one that takes the intuitive notion of contrast as both the defining characteristic of foci and the source of

these behavioral effects. In the next chapter (Chapter 2) I argue that a notion of contrastive alternatives allows us to put forward more specific hypotheses about the link between the interpretational effects of focus and its behavioral signature, which the subsequent chapters (Chapters 3-5) then aim to test.

In order to contextualize these hypotheses, the remainder of this chapter will lay out the guiding assumptions that underlie this approach. This introductory chapter is intended for a broad audience, and it serves to outline both what my general commitments are regarding the types of operations that are involved in the incremental interpretation of discourse, and how this approach can be distinguished from more common approaches to the incremental interpretation of language taken in theoretical semantics.

1.1 Guiding assumptions

There are three broad assumptions that underlie the approach to focus processing I take in this dissertation. The first is that in order to assign meaning to linguistic forms, comprehenders construct mental representations that contain information beyond what can be directly observed (I will refer to this assumption as ABSTRACT REPRESENTATION). Of course, the assumption that some abstract representations must exist in order to describe the way languages are structured and interpreted is uncontroversial in theoretical linguistics, but note that this assumption here specifically pertains to the corresponding mental representations that comprehenders construct during real-time language comprehension. The second assumption is that such mental representations can already be built before the end of the sentence is perceived (INCREMENTALITY). The third is that the incremental construction of such mental representations is guided by comprehenders' knowledge of the possible structures and meanings that are permitted in their language and information from the linguistic

discourse context, but that it is also shaped by the domain-general cognitive mechanisms through which such representations are constructed (COMPETENCE-PERFORMANCE). I argue that a real understanding of focus comprehension must be able to distinguish between ways in which the mental representations involved in its incremental interpretation depend on linguistic and non-linguistic factors. I motivate these assumptions in turn below, and address for each of them how they may apply to the comprehension of focus.

1.1.1 Abstract representations

I assume that comprehenders understand a sentence not only by identifying the words it contains, but also by combining these words into larger and larger constituents. Along with many others in sentence processing, I assume that a comprehender assigns a structural analysis to a sentence in which each word is assigned to a single immediate phrase and in which each phrase is related to all the other phrases in a sentence in a tree structure that specifies the hierarchical relations among these phrases. This structure may be augmented by traces, covert operators and other silent elements, which are not present in the string of words that is read or heard, but which provide crucial information about the way these structures are interpreted (Clifton Jr & Frazier, 1989; Fodor, 1989, 1993).

I assume that interpreting a sentence also involves building mental representations of the meaning of such structures, i.e., representations in which the meaning of the individual words and phrases are composed according to the structural analysis that is entertained. Because comprehenders are generally able to interpret dependencies between pieces of linguistic structure that span across sentence boundaries—as in the interpretation of discourse anaphora, for instance—it must also be the case that these representations of meaning are somehow incorporated into a representation of the discourse context, which comprehen-

ders are able to maintain and update over time. Although I assume that all three types of representations (structural, semantic and discourse) can be built simultaneously, I also assume that a structural analysis of a sentence is generally necessary to provide support for its semantic interpretation, which is presumably a precursor to the evaluation of certain properties of the derived meaning, such as plausibility or coherence with the discourse context.

One major question is what such representations look like exactly. At the level of discourse in particular, it is not always clear at what level of granularity discourse information is maintained or how a representation of the discourse should be updated with incoming information. This dissertation takes the comprehension of focus as one way to address this general question of the representations involved in discourse comprehension.

With respect to focus, this dissertation argues that its on-line interpretation involves such abstract representations as well. Note that some notion of abstract representation is already necessary under the above understanding of focus, exactly because focus signals a contrast with unpronounced material. But more specifically, I take focus itself to be an abstract category that is part of the structural make-up of a sentence, following similar treatments in the theoretical literature on focus (Jackendoff, 1972; Rooth, 1985, 1992b). Therefore, the presence of focus marking, like other structural properties, is abstract in the sense that it must always be inferred from the auditory or visual signal that comprehenders are presented with. In addition to assigning a structural analysis, I assume that the set of alternatives a focus evokes must also be inferred in some way in order to derive its interpretational effects.

Exactly how comprehenders derive these abstract representations of focus is particularly puzzling because, for focus in particular, the bottom-up signal often largely underspec-

ifies their nature. For instance, although foci are typically marked as prosodically prominent in English, the material in focus can be, and often is, larger than the element that is prominent, a phenomenon that is called “focus projection” (Chomsky, 1971; Selkirk, 1984, 1995). This is illustrated in (3), which despite the prominence on *dinosaurs*, can have foci of different sizes, as shown in (3a-c).

- (3) a. Sarah only read an article about [DINOSAURS]_F (...not about penguins)
 b. Sarah only read [an article about DINOSAURS]_F (...not a book about bats)
 c. Sarah only [read an article about DINOSAURS]_F. (...she did not go fishing)

In (3a), it is articles about, say, penguins that are excluded by *only*, while (3b) conveys that Sarah did not read anything besides an article about dinosaurs, and (3c) conveys that Sarah did not *do* anything other than read an article about dinosaurs.

Because the edges of a focused phrase do not necessarily align with the edges of the most prominent element in the utterance, mapping a prosodic structure to an underlying focus structure during sentence comprehension is therefore not always straightforward. Though prosody or the presence of a focusing construction can provide a cue towards the presence of a specific underlying focus structure, it often proves insufficient evidence in favor of a specific analysis.

Even when prosody fully specifies the placement of focus, the nature of the alternative set can still vary greatly depending on the context in which the focus is uttered. For instance, the set of alternatives that may come to mind in (4b) is different from that in (5b) (example adapted from Kim et al. 2015).

- (4) a. Beth wants to make a pie. She’s asking her roommates if they have any ingre-

dients to make one.

- b. Sarah only has some APPLES_F.
- (5)
- a. Sarah is alone in the kitchen at night when she hears a burglar trying to break in. She looks around for something she can pelt him with as he comes through the window.
 - b. Sarah only has some APPLES_F

Contextually appropriate alternatives to *apples* in (4b) would for instance include expressions like *flour*, *sugar*, *butter* or *eggs*, whereas contextually appropriate alternatives to *apples* in (5b) would include *eggs* in addition to *knives*, *spoons* and *plates*, but crucially not *sugar* or *flour*. In (4), the alternative set is typically inferred to be restricted to pie ingredients, while in (5) it is restricted to throwable items that Sarah may have defended herself with. Since the semantic contribution of *only* is to negate such alternatives, we therefore typically do not infer that Sarah does not have any sugar or flour in (5b) while we do draw this inference in (4b). Thus, another way in which the surface structure of a focus underspecifies its abstract representation is in the nature of the alternative set that is evoked.

This dissertation asks how comprehenders, in light of surface material that often severely underspecifies the abstract representations that must be inferred, are still able to make such inferences about foci and their alternatives. Upcoming chapters investigate this by studying how comprehenders rely on representations of the discourse context, as well as general knowledge, to disambiguate both the underlying focus structure and its evoked alternative set.

1.1.2 Incrementality

The second guiding assumption I make is that natural language interpretation is fundamentally incremental: readers or listeners do not wait until the end of a sentence to construct the abstract mental representations I outlined above, but instead start building them as soon as incoming information is available. Longstanding evidence in psycholinguistics suggests, for instance, that word recognition occurs extremely quickly (Ehrlich & Rayner, 1981; Marslen-Wilson et al., 1987), and that the resolution of pronouns can occur rapidly after they are encountered (Nicol, 1988; Shillcock, 1982). Evidence from the way comprehenders deal with (temporally) ambiguous structures also suggests that structure building is highly incremental. The crucial observation is that disruptions in processing occur at moments that correspond to points at which the structure of a sentence is disambiguated (Frazier & Rayner, 1982; Kennedy & Murray, 1984; Mitchell & Holmes, 1985; Ferreira & Clifton Jr, 1986; Frazier & Rayner, 1987; Flores d'Arcais, 1990; De Vincenzi, 1991; Frazier & Clifton, 1996). For instance, readers typically have trouble with a sentence like (6) despite the fact that this is a perfectly grammatical sentence in English.

(6) ?The old man the boats.

This is because there is a strong tendency for readers, upon initial processing, to analyse the beginning of this sentence (*the old man...*) as a noun phrase, consisting of a determiner, an adjective and a noun. However, when subsequently reading the second noun phrase *the boats*, this initial parse must be re-analyzed into an analysis in which the initial sentence fragment instead consists of noun phrase (*the old*) and a verb (*man*). Indeed, disruptions in processing can be observed when comprehenders are reading such sentences. These disruptions can be observed mid-sentence, typically at the point in time at which the initial analy-

sis is falsified against incoming input (Frazier, 1987; Rayner & Morris, 1991)—suggesting that comprehenders do not wait until the end of the sentence to construct and reconsider these analyses.

Thus, language comprehenders seem to construct a particular analysis of a sentence early on; they do not wait until all potentially disambiguating information is gathered. In fact, because comprehenders also rely heavily on top-down grammatical knowledge, they can in some cases also anticipate upcoming structure in light of what has already been observed—for instance, the presence of a noun phrase can already be anticipated upon the recognition of the initial determiner.

Throughout this dissertation, I ask to what extent the processing of focus also takes place in a similar incremental and predictive fashion. In the following chapters, I will use the fact that sentences are often ambiguous with respect to both their focus structure and evoked alternative set to show that, similar to the structural analysis in examples like (6), comprehenders commit to a particular focus structure of ambiguously focused sentences (Chapter 4) and to a particular set of alternatives evoked by a focus (Chapter 5) early on. I therefore propose that the comprehension of focus fits into this more general picture of incremental interpretation in that it involves the continuous updating of potential focus structures and their corresponding alternatives.

Before introducing the third assumption I make, below I quickly outline how the approach to incrementality I take here is different from the one adopted in dynamic theories of meaning, which also take the incremental interpretation of language as their starting point.

1.1.2.1 Comparison to dynamic theories of meaning

Similar to the approach outlined here, dynamic semantics adopts the view that the meaning of a sentence lies “in the way in which it changes (the representation of) the information of the interpreter” (Groenendijk & Stokhof, 1991). The semantic system proposed by Groenendijk & Stokhof, Dynamic Predicate Logic (DPL), allows for representations in which each basic unit is interpreted in the context created by the interpretation of the text so far. Although the view on incremental interpretation I adopt here is rooted in a similar intuition it is also crucially different from such theories—in three particular ways.

The first is that, under the present perspective, I assume that the information state of an interpreter is updated word-by-word, whereas in most dynamic semantic systems, the order in which states are updated is determined by the semantic structure, not by left-to-right order (Lewin, 1992; Milward & Cooper, 1995). An example where these two may come apart is in conditionals such as (7).

(7) Sarah will read a book about bats, if she has some spare time.

In DPL states are updated first with the antecedent of a conditional (*if she has some spare time*) and then with the consequent (*Sarah will read a book about bats*). This is because the dynamic updates are still defined with respect to truth conditions: Truth-conditionally, the consequent needs to be interpreted relative to, and therefore after, the antecedent. In interpreting (7) using such a system, the input state for evaluation of Sarah reading a book about bats is the output state from the antecedent. But crucially in (7) the antecedent conditional is not presented before its consequent, and the incremental interpretation therefore takes place in the opposite order. Indeed, Brasoveanu & Dotlacil (2015) provide experimental evidence which suggests that conditionals with a sentence-final if-clause are still interpreted in a left-

to-right fashion, such that the matrix clause is already interpreted before *if* is reached.

In short, it is not possible to directly understand the states proposed in dynamic semantics as mapping onto the mental representations involved in word-by-word interpretation, because those states are not fine-grained enough to make predictions about incrementality below the sentence level. This problem is not restricted to DPL, but applies equally to other dynamic frameworks such as Discourse Representation Theory (Kamp, 1981) or File Change Semantics (Heim, 1982).

Relatedly, systems like these do not account for the fact that comprehenders may have to re-analyse the meaning of a sentence based on incoming input. An understanding of word-by-word interpretation, on the other hand, naturally predicts re-analysis costs because abstract representations are already constructed before all possible information towards the correct structure has been gathered. Dynamic theories of meaning do not aim to predict such effects; their goal is to provide a theory of how information states are updated, not of the way in which comprehenders determine what the intended update consists of.

This brings me to the third difference between dynamic theories and theories of incremental behavior, which is that dynamic theories are competence level theories: they are intended to describe comprehenders' knowledge but make no explicit reference to the domain-general knowledge and mechanisms that may be utilized in incremental interpretation. As is, these systems do not provide a clear strategy for investigating where comprehenders' linguistic knowledge (i.e., COMPETENCE) ends and their general cognitive strategies (i.e., PERFORMANCE) begin. I take this to be an important shortcoming of such theories, because, as the example in (6) already illustrates, the apparent infelicity of a sentence or unavailability of certain reading may be due to properties of the processing system, not to the grammatical system encapsulated within it. The issue, more generally, is that there's

no such thing as linguistic behavior that is *not* filtered through a general system of comprehension, and it is therefore a priori not known what the desiderata of theories of linguistic competence should be.

This, then, is also the third assumption that underlies the approach I take, namely that progress in understanding what the mental representations involved in incremental interpretation look like will only be possible through a deeper understanding of the degree to which they are a product of comprehenders' linguistic knowledge, as opposed to general knowledge and comprehension pressures.

1.1.3 Competence-Performance

There are thus several sources of influence that affect comprehenders' behavior, and I argue here that it is important—not just for psycholinguistics but also for theories of semantic competence—to be able to distinguish those.

On the one hand, I take it to be crucial that readers and listeners generally try not to violate their knowledge of grammar in incrementally constructing their analysis of a sentence, because the goal of these structure- and meaning-building processes is to map the perceived words onto a well-formed and interpretable structure. Therefore, comprehenders' knowledge about the constructions that are permitted in their language must somehow guide the decisions they make as to what mental representations to construct.

But on the other hand, the interpretation of ambiguous structures also teaches us that grammatical knowledge is not sufficient for comprehenders to arrive at a final interpretation. This is apparent in example in (6) above: the fact that disruptions in processing appear when one analysis is falsified suggests that comprehenders must arrive at their initial analyses based on information that is not provided by their knowledge of the grammar alone. In some

cases, the preference for a particular parse may be due to general processing principles, or—since comprehenders are typically able to arrive at the most plausible or contextually appropriate meaning—information from the discourse context, as well as conceptual and general world-knowledge may also play a role (Marslen-Wilson et al., 1987; Frazier, 1987; Altmann & Steedman, 1988)

I thus distinguish between linguistic representations on the one hand, and non-linguistic effects on comprehenders' incremental interpretations, on the other. The first includes knowledge of the grammar, possible ways in which words may be composed to form complex meanings, and ways in which comprehenders track such semantic information throughout larger discourses; the second may involve information about plausibility or salience, conceptual relationships between lexical expressions, general world-knowledge, and effects due to limitations in general processing resources comprehenders have at their disposal, such as memory and attention. Focus provides a particularly fertile testing ground for investigating the interactions between these exactly because the interpretation of foci must involve a combination of linguistic representations and general reasoning. This is already illustrated in (4) and (5), where nature of the evoked alternative set heavily depended on general world-knowledge of the possible objects and situations involved.

Another goal of this dissertation is therefore to study explicitly what aspects of the comprehension of focus may be guided by domain-general factors, and which aspects may be specifically due to comprehenders' structural, semantic or discourse representations. For instance, Chapters 3 and 5 address what the relationship is between these linguistic representations and general cognitive mechanisms such as semantic associate priming. Results from these chapters show the comprehension of focus fits into this more general picture in that its incremental construction of abstract representations is not only guided by domain-

general knowledge and the general cognitive mechanisms for utilizing this knowledge, but also by comprehenders' representations of discourse and the potential focus configurations that are compatible with it.

1.2 How this dissertation is structured

The goal of the next chapter (**Chapter 2**) is to further outline how the behavioral evidence regarding the processing of focus could be brought more in line with the notion of focus proposed in the theoretical semantics, without losing sight of the way general comprehension pressures may shape its interpretation. I argue that this is possible by studying how the mental representations involved in the processing of focus are incrementally constructed during sentence comprehension. This chapter builds on the three guiding assumptions discussed above to formulate two hypotheses about the processing of focus. First, it puts forward the hypothesis that focus processing is INCREMENTAL:

Hypothesis 1. The time-course of focus processing (INCREMENTALITY): Comprehenders complete the processes necessary to interpret a focus as soon as the relevant information becomes available.

Second, it posits that, independently from general knowledge and mechanisms, ABSTRACT REPRESENTATIONS are also involved in the comprehension of focus:

Hypothesis 2. Representations of focus processing (ABSTRACT REPRESENTATIONS): Alongside the basic structure and meaning of an utterance, comprehenders also construct representations of focus structure and of the evoked alternative set.

Subsequent chapters experimentally test and refine these hypotheses using reading measures, which are particularly suited to probe incremental interpretation.

Chapter 3 shows, first, that the comprehension of focus generally induces a processing cost because reading times on foci are longer than on non-foci. It then shows that this cost is reduced when contrastive alternatives to the focus are mentioned in the preceding context, suggesting that the representation of contrastive alternatives is indeed involved in the comprehension of focus. This chapter also provides evidence for Hypothesis 2, because it shows that the presence of focus marking induces a cost that is separable from a cost of interpreting newly introduced information, and that the presence of alternatives provides a reading benefit that is separable from a benefit due to semantic priming. Together, these findings suggest that contrastive alternatives must somehow be involved in the processing of focus, and that its cost, as well as its modulation by contrastive alternatives, cannot be explained in terms of a general cost for new material.

Chapter 4 investigates how context is used to assign a focus structure to a sentence in incremental sentence comprehension. It shows that the presence of contrasting material in the context is used by comprehenders to assign focus marking to subsequent sentences, providing supportive evidence for both Hypothesis 1 and 2 because representations of contextual contrasts are utilized to anticipate the location of an upcoming focus. Again, results indicate that these behavioral effects of focus are separable from effects of newness or the predictability of upcoming material in general. This suggests that it is crucially the fact that comprehenders encode abstract representations of contextual contrasts that gives rise to these behavioral effects of focus, not communicative importance alone.

Chapter 5 studies what information comprehenders rely on in constructing an alternative set to a focus. This chapter again provides evidence for the claim that linguistic

representations of the context are used to either rule in or rule out potential members of the alternative set to a focus. It shows that the deployment of these types of representations is fast (supporting Hypothesis 1), and independent from the use of general conceptual knowledge or the use of domain-general mechanisms such as semantic priming (supporting Hypothesis 2).

Finally, **Chapter 6** concludes this dissertation by arguing that comprehenders arrive at a final interpretation of a focus by combining multiple sources of evidence, including lexical, conceptual and world-knowledge, as well as fine-grained linguistic representations that guide the incremental interpretation of focus independently from such general knowledge.

1.3 Miscellaneous remarks

1.3.1 Terminology: bound vs associated foci

In order avoid confusion with the psychological notion of semantic association, I will refer to foci that are associated with a focus particle or cleft as *bound foci* throughout this dissertation. The term *association* will solely be used to refer to conceptual relatedness from here on.

1.3.2 Data Availability

All materials, data and analysis code of the experiments reported in this dissertation are made available via the Open Science Framework and can be accessed at https://osf.io/jvkg8/view_only=01947825eebe49c488ee386935ccb387.

Chapter 2

A framework for focus processing

2.1 Introduction

Focus has been studied extensively, both in theoretical linguistics and in psychology and psycholinguistics, but these two lines of research have so far mostly remained separate. The goal of this chapter is to provide a framework for focus processing which brings together the separate strands of behavioral evidence outlined in the previous chapter, and that simultaneously brings this behavioral evidence more in line with the notion of focus proposed in the theoretical literature. I argue that this is possible by studying how the mental representations involved in the processing of focus are constructed in real-time processing, and are based on a combination of comprehenders' domain-general, conventional and grammatical knowledge.

Behaviorally, the comprehension of focus marking has been argued to require more processing resources than non-focused material, leading to longer reading times on foci than on non-foci (Birch & Rayner, 1997; Benatar & Clifton, 2014; Lowder & Gordon, 2015). On the other hand, foci—or the placement of a focal accent—can also be anticipated and are often understood as being prioritized over non-foci in sentence processing, leading to deeper

encoding (Singer, 1976; McKoon et al., 1993; Birch & Garnsey, 1995a; Gernsbacher & Jescheniak, 1995) and in some cases to faster reading times on foci (Birch & Rayner, 2010; Morris & Folk, 1998). Finally, the presence of focus marking on a given expression has been shown to lead to the differential activation and encoding of expressions that contrast with it (Braun & Tagliapietra, 2010; Washburn et al., 2011; Fraundorf et al., 2010, 2013; Husband & Ferreira, 2016; Gotzner et al., 2016b; Yan & Calhoun, 2019). In this chapter, I argue that these disparate findings can be unified by an understanding of focus in which contrastive alternatives play an important role in the prioritization and anticipation of, as well as the cost induced by, foci.

In the previous chapter, I also outlined some of the relevant takeaways from the theoretical literature. Before discussing the general approach I take in more detail, I summarize these points here in order to point out what specific questions remain about the relationship between formal and mental representations of focus. In Section 2.2 I then further motivate the approach to focus processing in terms of mental representations, and subsequently use this view in Section 2.3 and 2.4 to provide a unified understanding of the experimental findings in this dissertation.

2.1.1 Identifying the gaps between theory and the behavioral evidence

It is generally understood that discourse context governs the well-formed placement of focus (Chomsky, 1971; Jackendoff, 1972; Rooth, 1985, 1992a; Krifka, 2006; Roberts, 1996). But although the dependency between context and focus marking has been studied to some extent in psycholinguistics (Kim et al., 2015; Fraundorf et al., 2010, 2013), it is still not known what representations of the discourse context comprehenders use in the processing of focus. Broadly, the main goal of this dissertation is therefore to investigate

how foci are interpreted in context.

One particular way in which this dissertation studies how the comprehension of focus depends on context is by investigating how comprehenders use contextual information to derive the intended focus structure of sentence. As outlined in the previous chapter, focus is prosodically marked in English, but not all focused material is also marked as prosodically prominent because there is a non-trivial mapping between focus prosody and the underlying focus structure (Gussenhoven, 1983, 1992; Selkirk, 1984, 1995; Féry & Samek-Lodovici, 2006). Sentences with a particular prosody may still be compatible with multiple underlying focus structures. In these cases, it is the preceding context—and not the prosody of an utterance—that disambiguates where the edges of a focus marked phrase lie. But the way in which comprehenders use contextual cues to assign a focus structure to such ambiguous sentences in incremental sentence processing is still mostly unknown.

At the same time, the fact that there is no one-to-one mapping between focus and prominence also raises the question of whether the behavioral effects of focus and prominence are potentially separable, too. Most of the psychological literature has investigated foci that are also prosodically prominent, and it is therefore not always clear whether the observed effects indeed stem from the underlying focus structure, as opposed to the prosodic signature of these constructions. Another goal of this dissertation is to disentangle effects of focus from effects of focus prosody, and to show that it is the abstract category of focus itself (and not just the prosodic signature) that has important ramifications for the way sentences are processed.

In the previous chapter I also argued that the interpretation of foci depends on a set of contrastive alternatives (Jacobs 1983; König 1991; Rooth 1985, 1992a; Roberts 1996; Krifka 2007; D. I. Beaver & Clark 2008 among many others), although there is some dis-

agreement about what formal characterization of alternative is the right one (Katzir, 2007; Wagner, 2006a; Büring, 2019; Buccola et al., 2022). Because such alternative sets are generally thought to be contextually restricted in some way, it is also widely accepted that the nature of the alternative set evoked by any given focus is dependent on context. In order to compute the intended inferences of an utterance during on-line interpretation, comprehenders need to reason about the nature of these evoked alternatives, which may be left implicit. In psycholinguistics, it has indeed been shown that the comprehension of focus leads to the activation of expressions that implicitly contrast with the focus, but again, exactly how the process of alternative set construction depends on context has received less attention. This dissertation therefore also studies, broadly, how information from the discourse context may affect the construction of alternative sets to a focus.

Finally, although empirically the two often track each other, the notion of focus is often understood to be conceptually distinct from that of givenness (Chafe, 1976; Selkirk, 2008; Féry & Samek-Lodovici, 2006; Wagner, 2006b; Büring, 2019; Kratzer & Selkirk, 2020). This conceptual distinction but empirical overlap between the notions of focus and givenness raises a number of questions about their effects on processing. To my knowledge, no existing study has manipulated the presence of focus marking independently of givenness, and it is therefore not clear how their behavioral signatures may come apart.

There are thus many open questions related to the way in which the formal representations proposed in the theoretical literature can be linked to processes that make up the incremental interpretation of foci. More generally, this dissertation therefore aims to bridge these literatures by showing that the concepts employed in formal semantics can be tightly connected to the mental representations comprehenders engage with in real-time comprehension. In this chapter, I argue that this connection can be achieved by assuming that some

of the objects adopted in formal semantics correspond in some way to the goals of the system that language users utilize in interpreting language in real time. That is, I argue that the components that make up the formal representation of focus can be taken to correspond to the necessary subprocesses that make up the comprehension of focus.

This chapter then puts forward two broad hypotheses about these subprocesses. The first is about the time-course at which they are completed: I hypothesize that comprehenders generally complete the subprocesses that make up the comprehension of focus as early as possible, as soon as available information allows them to do so. The second involves the types of representations involved in these subprocesses: it states that comprehenders, when possible, specifically encode representations of contextually relevant contrasts and that such representations can be maintained, re-accessed and updated over time. Before discussing how this dissertation tests these hypotheses in more detail, below I first define the notion of mental representation and its relationship to formal representation.

2.2 Defining mental representations

A sentence like (1) typically gives rise, at least, to the inference in (1b).

- (1) Lily read a book about whales and penguins, but Sarah only read a book about BATS
- a. \leadsto Sarah did read a book about bats
 - b. \leadsto Sarah did not read a book about whales

In this section, I will first describe what the formal systems that derive this inference typically look like, before moving on to discuss how this inference may be computed when a

sentence like (1) is perceived word-by-word. Although there is reason to believe that the formal representations coined in the theoretical literature do not always directly map onto the mental representations used to construct sentence meaning in real time, a formal understanding of the phenomenon allows us to gain traction on the specific types of information that needs to be computed in order to interpret the sentence as a whole. This understanding will then help in studying how exactly such information is incrementally gathered as well.

In this chapter, I will mostly focus on alternative-based theories of focus which rely either on salient sets of alternatives (Rooth, 1992b) or questions-under-discussion (Roberts, 1996). In Chapter 6, I will discuss how the findings of this dissertation relate to non-alternative-based theories of focus, such as Schwarzschild's (1999) theory of givenness or a structured meaning approach to focus semantics (Krifka, 1992).

2.2.1 Formal representations: pieces of information necessary to determine meaning

Broadly, the formal representations involved in the interpretation of a sentence like (1) and the derivation of the inference in (1b), must consist, at least, of: 1 some abstract representation of the presence of focus marking (here referred to as F-marking); 2 some algorithm for computing the alternatives evoked by F-marking; 3 some component that governs the context-dependence of F-marking and the evoked alternatives; and 4 some way of spelling out how the resulting alternative set is incorporated into the sentence meaning. Below I discuss each of these components, summarized in (2), in more detail.

(2) Four minimal components to derive (1b)

1 F-marking

- 2 Evoked alternatives
- 3 Dependency with the context
- 4 Semantics of *only*

Any theory of focus must also specify how F-marking is spelled out phonologically, but below I will not be discussing this component further, because this dissertation is mainly concerned with the way meaning is incrementally constructed, not how a prosodic signal is parsed into a phonological or syntactic structure. I will therefore be making the simplifying assumption that whatever this algorithm looks like, it is part of comprehenders' grammatical knowledge and so for any sentence with a well-formed prosody comprehenders are able to reconstruct the focus configurations that would be compatible with it.

1 F-marking

Formal accounts of focus marking include at least some abstract representation of focus, or *F-marking* as I will refer to it here. In most cases, this abstract representation is understood as a feature that is part of the syntactic structure of a sentence (Rooth, 1985; von Stechow, 1982; Krifka, 1991, 2007; Steedman, 1991). Under this treatment of F-marking, it is the presence of this abstract representation that mediates the prosodic and semantic effects of focus. For instance in the sentence in (2), F-marking would be placed solely on the constituent *bats*, as indicated with a subscript F below.

(1) Lily read a book about whales, but Sarah only read a book about [BATS]_F

The presence of F-marking then gives rise to both the phonological and interpretational effects of focus marking. Effects of the latter type arise because the presence of focus evokes

a set of alternatives that contrast with that focus. I address the nature of these evoked alternatives next.

2 Evoked alternatives

The next component specifies how the placement of focus marking gives rise to a set of alternatives. With F-marking on *bats*, the contrastive alternatives to (2) would be computed, roughly, by replacing *bats* with other expressions that contrast with it. The exact contents of the resulting alternative set depend on the specific algorithm that is adopted for the generation of alternatives. For instance, Rooth (1992a) adopts a relatively unrestrictive characterization of alternative sets, where the focus alternatives to an F-marked expression corresponds to the set of denotations that are of the same semantic type as the F-marked expression itself. To illustrate this, I adopt the notation used by Rooth here, where I refer to the ordinary meaning of an expression as its o-value (denoted as $\llbracket \cdot \rrbracket^o$), and to the alternatives evoked that are evoked as its focus value (denoted as $\llbracket \cdot \rrbracket^f$). The o-value and f-value of the constituent in (2) to which *only* is attached would thus be as in (3).

- (3) a. $\llbracket \text{read a book about bats}_F \rrbracket^o = \lambda x. \lambda w. x \text{ read a book about bats in } w$
 b. $\llbracket \text{read a book about bats}_F \rrbracket^f = \{ \lambda x. \lambda w. x \text{ read a book about } y \text{ in } w$
 $| y \in D_{\text{type}(\text{bats})} \}$

This particular way of generating of alternative sets via semantic type does not place any further restrictions on the meaning of these contrastive alternatives themselves, but there are other proposals which suggest that the alternatives that are evoked are already narrowed down further, for instance by imposing certain structural requirements on the linguistic expressions that replace the focused expression and give rise to the alternative set (Fox &

Katzir, 2012), or by suggesting that the resulting alternatives themselves need to have particular pragmatic properties (Wagner, 2006a; Büring, 2019).

3 Dependency with the context

The meaning of sentences with a focus sensitive expression is not solely determined by focus positioning and syntax, however. Context has a restricting effect on the interpretation of focus marked sentences. Again, there are different ways of implementing this contextual restriction. In Rooth's (1992a) Alternative Semantics, for instance, this effect is captured by imposing the condition on the alternatives that are evoked by a focus to be a subset of a set of alternatives that is made salient by the context. This requirement stems from a focus operator \sim , which attaches to a constituent containing F-marking φ and comes with a silent pronoun C that picks up on such a salient set of alternatives. The operator \sim then gives rise to the presupposition that the antecedent of C is a subset of the focus semantic value of the constituent it attaches to.

- (4) $[\varphi] \sim C$ introduces the presupposition that C is a subset of $[[\varphi]]^f$ containing $[[\varphi]]^o$ and at least one other element.

This operator allows for an account of the observation that well-formed answers to wh-questions need to contain F-marking on the constituent corresponding to the wh-phrase. In a widely adopted semantics of questions (Hamblin, 1973), the meaning of wh-questions denote the set of their possible answers, which can be derived from substituting the wh-word with a variable that ranges over type-appropriate alternatives. The \sim operator thus ensures that the alternatives made salient by that question (i.e., its potential answers) are a subset of the f-value of the answer.

The dependency between context and focus can also be captured, more generally, in terms of general pragmatic principles that govern the way discourses are supposed to unfold. For instance, under Roberts' question-based model of discourse structure, the ultimate goal of interlocutors is to jointly answer the question *What is the way things are?*. In a coherent discourse, interlocutors set up strategies for answering this broad question using sequences of more specific sub-questions, and the statements they make generally have to be relevant to whatever current question is being addressed. The role that focus marking plays within this model is to signal what specific question an utterance pertains to. Roberts (1996) uses the general notion of *congruence* to account for the relationship between focus and context, and imposes the condition that a declarative utterance should evoke a set of alternatives that is identical to the alternatives of the current question (see also D. I. Beaver & Clark 2008; Büring 2003).

- (5) Move φ is congruent to a question ψ iff its focal alternatives $[[\varphi]]^f$ are the q-alternatives determined by ψ , i.e., iff $[[\varphi]]^f = [[\psi]]^o$.

Note that under this approach, unlike Rooth's, there is no difference between the alternatives that are evoked by the placement of F-marking and the alternatives that are salient in the context. The evoked alternative sets in this account are already restricted to the alternatives relevant for the current question under discussion. In this treatment of focus the dependency between focus and context arises specifically due to the presence of a question. In statements that do not form answers to explicit questions, it is thus assumed that the current question they make reference to is left implicit.

In general, both approaches to contextual restriction require comprehenders to reason about what set of alternatives, or what (implicit) question, is relevant in a given discourse,

and this reasoning then determines the nature of the alternative set.

4 Semantics of *only*

Finally, the evoked alternatives must somehow enter into the basic meaning of a sentence. In a Roothian account of focus, the denotation of focus particles such as *only* makes direct reference to the alternative set evoked by a focus they associate with. Under such an account, anaphorically-determined alternatives enter into the truth-conditional meaning of sentences via the lexical semantics of focus-sensitive expressions (Rooth, 1992a). But alternatively, the evoked alternatives could also enter in the meaning of a sentence via pragmatics, for instance by restricting the domain that these operators quantify over (von Stechow, 1999; D. I. Beaver & Clark, 2008; Roberts, 2012). Again, both possible ways in which alternatives affect the meaning of a sentence involve some knowledge on the comprehenders' part, either about lexicalized representations or about conventional pragmatic routes for domain restriction.

2.2.2 Incrementally gathering information

In short, under any account of focus, what it means to understand the meaning of (1) is to know, minimally, the information outlined in [1]-[4]. Although there are multiple ways of formally implementing these components, since the goal of this dissertation is to understand how foci are interpreted from a comprehenders' perspective, I mostly abstract away from these exact implementations here. Instead, I use these formal representations in broad strokes to define the pieces of information that need to be gathered in order to understand the basic meaning of a focus marked sentence.

In terms of a human comprehender gathering this information in real time, there is an

intuitive sense in which, when perceiving (1) word-by-word, the pieces of information in [1]-[4] may not come to us one-by-one. For instance, even in listening—where comprehenders have full access to the intended prosodic signature—the second clause of this example, repeated here in (6), is in principle compatible with multiple focus structures, as shown in (6a-c).

- (6) Sarah only read a book about BATS
- a. Sarah only read a book about [BATS]_F
 - b. Sarah only read [a book about BATS]_F
 - c. Sarah only [read a book about BATS]_F

Listeners (or readers) therefore need to somehow reconstruct the underlying focus structure of the entire sentence, repeated in (7), based on information other than its prosodic signature. One way in which they may be able to do so in this case is the fact that the preceding clause sets up a contrast between *whales*, *penguins* and *bats*, thus signalling that the relevant alternative set may consist of alternatives to *whales* and *penguins* (and not, let's say, alternatives to larger constituents).

- (7) Lily read a book about **whales** and **penguins**, but Sarah only read a book about **BATS**

Perhaps the only way in which focus can be assigned in (1) is if comprehenders also rely on information about the alternative set that is provided by the preceding material.

This also means that in cases like these—in which a focus stands in contrast with overt preceding material—it may be that focus structure is disambiguated even before the focus

itself is encountered. That is, having read the first clause and the beginning of the second starting with *but Sarah*, readers may already be aware of the fact that upcoming information about Sarah will be contrasted with the fact that Lily read a book about whales (3). After having then encountered the word *only* (4), readers may also be aware that some upcoming phrase is intended to evoke a set of alternatives (2). Possibilities for the exact extent and location of the focus that evokes these alternatives may then be incrementally narrowed down as the final words of this sentence are being read (1). In this case, because *read, a book* and *about* are already mentioned in the preceding clause, readers may already expect the word following these words (*bats* in this case) to provide (part of) the relevant contrast.

In short, numbering these pieces of information in 1-4 only tells us something about the dependencies between them, not necessarily about the way such information is computed in real time. The example above may already suggest that the dependency between context and focus does not always have to be backward-looking—i.e., a dependency with the context does not have to be established only after a focus is recognized. However, the dependency between context and focus may not always be established in a forward-looking way either, because in some cases comprehenders may not know in advance what the relevant alternative set to a focus looks like. The way these pieces of information are determined depends on the context in which a focus occurs.

But this fact does not mean that deriving these pieces of information is not part of the comprehension of focus at all. In what follows, I will argue that thinking of the components in 1-4 as corresponding to subprocesses that are necessary for the complete interpretation of a focus during incremental processing allows us to better understand the behavioral signature of focus, too.

2.2.3 Mental representations: snapshots of the way meaning is incrementally constructed

I thus identify four subprocesses in the incremental interpretation of focus, which are defined in that their respective end-product is the establishment of [1]-[4].

(8) Four subprocesses in focus processing

- ① Assignment of focus
- ② Construction of the alternative set
- ③ Encoding a dependency with context
- ④ Incorporating alternatives into sentence meaning

These subprocesses may occur in different orders, because each of them may be triggered by representations formed due to the input at different points in time. In fact, because I define these processes in terms of their end-products and because, more generally, multiple pieces of information may be gathered simultaneously during sentence processing, it may be that the processes in ①-④ occur in parallel. Indeed, it may be that performing some particular mental computation may serve multiple end-goals. In practice it may in some cases be difficult to determine exactly at what precise moment one of these subprocesses ends and another one begins. Demarcating these processes is a simplification that I make here mostly because it allows us to understand the interpretation of focus as a complex comprehension process, while also providing a concrete suggestion for the source of this complexity. In particular, the fact that the processing of focus must minimally consist of these subprocesses allows us to divide the main question into at least two, more tractable, subquestions:

1. What are the ways in which the processes in ①-④ depend on each other?
2. What type of external information goes into each of the processes in ①-④?

I outline how this dissertation asks each of these questions in turn below.

In what follows, I will mostly discuss the processes in ①-③, and leave detailed investigation of ④ for future work (though see Chapter 6 for some concrete suggestions for the way in which this process could be investigated as well).

2.3 The interdependence of these subprocesses

In theory, there are many ways in which comprehenders may go about completing the processes in ①-③. It may be that focus marking is at times assigned based on a default parsing heuristic (see e.g., Harris & Carlson 2014, 2017 for suggestive evidence along these lines). Comprehenders may, for instance, simply assign any sentence the widest focus structure that is compatible with its prosodic signature, and only check after focus is assigned whether the resulting alternative set is congruent with the context. In this case, the assignment of focus thus precedes any context-sensitive computations, as in (9).

(9) ① → ② → ③

Alternatively, it may also be that focus is assigned predictively, based on information about the relevant alternative set available from context (Cutler & Fodor, 1979; Sedivy, 2002). In this case, the assignment of focus temporally follows the reasoning process about what alternatives could be evoked by it as well as the encoding of the contextually relevant alternative set, as in (10).

(10) ③ → ② → ①

The existing behavioral evidence already suggests that both are possible routes to the interpretation of a focus. The view on focus processing proposed here unifies these two routes by arguing, broadly, that the way in which the comprehension of focus takes place depends on the amount of relevant information available in the context. In other words, Chapters 3-5 test the following central hypothesis about the time-course of focus processing:

Hypothesis 1. The time-course of focus processing: Comprehenders complete the processes ①-③ as soon as relevant information becomes available.

This hypothesis suggests that some of the processes can be anticipatorily completed before the focus itself is encountered. And the time-course of these processes depends on the amount of information comprehenders have at their disposal.

This view also has consequences for the expected cost induced by the interpretation of any given focus, because the relative amount of cognitive resources necessary to interpret a focus at any given point in time also depends on context, that it depends on what processes are triggered (or are currently running) and what processes are already complete at any given moment in time. This predicts, more generally, that any measure of such a cost (e.g., response times) may yield variable outcomes, such that not all foci are comprehended alike. Below these predictions are spelled out in more detail.

2.3.1 Predictions: variable focus costs

Hypothesis 1 predicts that the cost induced by the processing of focus itself is different depending on whether the encoding of an alternative set (③) precedes the assignment of

focus marking (①) or vice versa. There are two general ways in which ①-③ could be completed:

1. **Backward-looking** checking against context: ① → ② → ③

The alternative set is computed based on the overtly signalled placement of focus, and the congruence of this alternative set is later checked against the context.

2. **Forward-looking** focus assignment: ③ → ② → ①

Available contextual information allows comprehenders to encode a relevant alternative set, which allows for the anticipation of an upcoming focus.

In the first case, no reasoning about the alternative set takes place before focus marking is assigned. This may happen for instance in a setting where focus marking is unambiguously signaled (e.g., via the presence of a pitch accent or focus constructions), but no information about the alternative set is provided by preceding material, thus triggering all of the processes in ①-④ only upon recognition of the focus itself, as shown in (11).

- (11) Only Sarah_F read a book about bats.
 |
 ① → ② → ③ → ④

In this case, although the assignment of focus structure (①) may be less costly than when not explicitly cued, constructing the alternative set (②) and encoding how it may fit into the larger discourse context (③) may still induce a cost that may be measurable in reading times on the focus *Sarah*. If no contextual information is available at all, comprehenders have to accommodate the nature of their interlocutor's intentions that would account for the relevance of the inferred alternative set, which may involve a significant amount of on-the-spot pragmatic reasoning that would not have to be performed if prior context explicitly

computed even when foci themselves have been mentioned before. It also predicts that foci should induce a cost even when they are not signaled prosodically. In fact, under this view, the presence of focus prosody may ease processing because it allows for the rapid assignment of focus structure.

Below I outline how each of the chapters in this dissertation tests these predictions in more detail. In all chapters, I use reading measures to probe the cost of interpreting a focus and its alternative set, where I take longer reading times on foci or their explicitly mentioned alternatives to indicate a higher cost of completing any of the processes in ①-④. In Chapter 3 in particular, I argue that the difference between forward- and backward-looking focus comprehension is in fact the source of the inconsistencies among the literature on focus processing that uses reading measures.

2.3.2 Testing predictions using reading measures

The view outlined above predicts reading times on foci to be shorter with more available contextual information that is relevant for the construction of the alternative set or the assignment of focus marking.

(13) Predicted response times on foci: ① → ② → ③ > ③ → ② → ①

This difference in processing cost may arise for two reasons: first, the process in ③ itself may take more time because information that is provided by context must be accommodated in the absence of such contextual information; and second, the processing of the focus itself may take more time in the absence of a rich enough context, because none of the subprocesses necessary to interpret the focus can be completed prior to the moment the focus is recognized.

I show throughout this dissertation that the reading times on foci can indeed be modulated by various contextual properties. Below I outline what specific aspects of the context is manipulated in each chapter.

2.3.2.1 Chapter 3

Chapter 3 investigates the role of the contrastive alternatives in the context on the reading of subsequent foci. Experiments in this chapter measure reading times on foci that are overtly signalled by either a focus particle or by a cleft, as in (14).

- (14) a. **Context A:** Did Sarah want apple pie for dessert? NO ALT
b. **Context B:** Did Sarah want apple pie for dessert, or chocolate cake? ALT

Target: Sarah said it was [apple pie]_F that she wanted for dessert

The question in (14b) asks which of two alternatives (apple pie or chocolate cake) Sarah wanted for dessert, and thereby specifies what alternatives to apple pie are relevant in this specific context. But although the question in (14a) mentions *apple pie*, it does not explicitly contrast it with potential alternatives. This chapter compares cases in which the placement of focus is overtly signaled but the nature of alternative set unknown (i.e., ① → ② → ③) with cases in which context preceding the focus already fully specifies the alternative set (i.e., ③ → ② → ①).

Results show that the presence of a narrow focus generally induces a slowdown in reading, but that the processing of focus is also facilitated when context signals the nature of the relevant contrastive alternatives to a focus. Moreover, since these conditions involve foci that have been mentioned in the preceding question, these experiments also show that focus can indeed cause slowdowns even on given material. This chapter then links these

results with findings in the reading literature on focus, and argues that the inconsistent results obtained there can also be explained in terms of the framework proposed in this chapter, because the only studies which found speedups on foci also presented contrastive alternatives in material preceding the focus.

2.3.2.2 Chapter 4

In Chapter 4, I further investigate the way in which foci may be anticipated based on preceding context (i.e., ③ → ② → ①). The experiments in this chapter involve sentences that are ambiguous with respect to the focus structure they contain, but in which context disambiguates focus structure, as in (15).

- (15) a. **Context A:** Did Sarah read a book about bats or penguins? NARROW
- b. **Context B:** Did Sarah read a book about bats or a report about penguins?
- WIDE

Target: I think Sarah said she only read [_A a book about [_B bats]_F]_F,...

Results from these experiments show that the behavioral effects of focus are modulated by contextually provided alternatives, suggesting that focus marking is assigned to sentences with an ambiguous focus structure based on such alternatives.

Again, this chapter involves given foci and shows that focus induces slowdowns even on material that is given. It moreover tests foci that are larger than a single word, which allows us to disentangle potential effects of the assignment of a pitch accent in the implicit prosody of a sentence from potential effects of the underlying focus structure itself. In (15), only the word *bats* would receive a focal accent even though when this sentence is preceded

by the question in (15a) the entire phrase *a book about bats* would receive F-marking. Because focus slowdowns were found at the left edge of these foci in these conditions (i.e., on *book*), such slowdowns could only be due to focus itself and not to newness or the assignment of an (implicit) accent.

2.3.2.3 Chapter 5

Of course, the picture may not be as black-and-white as the one outlined above and there may be more intermediate ways of completing these processes, for instance where the context suggests the relevance of a different alternative set than the one indicated in a particular sentence, or in which the alternative set may only be partially determined prior to the comprehension of the focus. Chapter 5, investigates cases of the latter type in more detail, i.e., cases in which the placement of focus is overtly signaled, and context provides some information about the alternatives to a focus but does not signal the relevance of that particular alternative set prior to the moment when the focus is encountered.

More concretely, this chapter investigates discourses as in (16), where potential focus alternatives are mentioned in the context (*cheese, milk,...*), but no contrast between the members of the alternative set is set up.

(16) **Context:** The tourist asked for a variety of items, like some cheese and some milk.

There was already an ashtray on the table.

Target: When the waiter returned, he remembered to bring only [milk]_F ...



This chapter argues that in these cases, focus is assigned first (①), but the full extent of the alternative set can only be determined after a dependency with the context has been

made (3) → (2). This means that information from the context needs to be revisited to determine what the content of the alternative set is.

Results also show that such contextual information is rapidly integrated to construct the alternative set to a focus, but that this process is only triggered by the presence of a focus-sensitive particle like *only* which provides an overt cue to the relevance of an alternative set. In the absence of *only* (and thus in the absence of focus marking), contextual information about the alternative set did not affect reading times. In these cases, the relevant representations of the context only affected comprehenders' reading behavior *because* of the processing of focus itself, suggesting that these contextual representations did not guide comprehension in the absence of clear cues to the presence of focus marking.

One question these results raise is what it is exactly that allows comprehenders to construct an alternative set ahead of time, and what type of contextual information is relevant for the process of alternative set construction. In the next section I discuss how this dissertation addresses these questions.

2.4 The dependence on external information

In order for information computed in the anticipatory completion of any the processes in (1)-(3) to actually affect the processing of a subsequent focus, it must be the case that the relevant representations can be maintained and updated over time. Together, Chapters 3-5 test the following hypothesis about these representations:

Hypothesis 2. Representations of focus processing: Alongside the basic structure and meaning of an utterance, comprehenders also construct representations of focus structure and of the evoked alternative set.

A more general question about the processing of focus that this hypothesis allows us to ask involves the nature of the mental representations involved in these sub-processes, and what level of linguistic structure they pertain to. The subsequent chapters also investigate what these representations look like, and what type of information is encoded by them.

So far, most studies in psycholinguistics have only investigated the processing of single words, i.e., either single-word foci or single-word alternatives (though see Lacina et al. 2022 for a notable exception). These studies showed that the processing of focus involves, at least, representations of lexical forms. For instance, focus is shown to facilitate lexical decision times of expressions that contrast with the expression in focus (Braun & Tagliapietra, 2010; Husband & Ferreira, 2016; Gotzner et al., 2016a). The faster responses in phoneme monitoring tasks obtained for foci could in part be attributed to a facilitatory effect of focus on the process of lexical access (Cutler, 1976; Cutler & Fodor, 1979). In this case, the presence of focus marking may facilitate phoneme detection because the lexical representations of foci are accessed quicker than those of non-foci.

In fact, lexical knowledge or general conceptual relationships between expressions play an important role in models that account for the way in which contrastive alternatives become activated during the processing of focus (Husband & Ferreira, 2016; Gotzner et al., 2016a). In these models, comprehenders are argued to activate contrastive alternatives during the processing of focus by spreading activation to expressions that are semantically associated to the expression in focus, and subsequently selecting proper alternatives from among those initially activated lexical associates.

But the notion of alternative as used in formal semantics typically involves representations of the denotation of pieces of linguistic structure, as outlined above. Alternatives may be determined based on pieces of structure larger than a single word. Although lex-

ical representations must definitely be involved in the comprehension of focus, one open question that remains is whether the computations involving focus and their alternative sets also involve more abstract representations than representations of the textbase or of individual lexical items; and if so what type of abstract representations they are. It could be that alternative sets are computed based on representations that involve e.g., the activation of (partial) syntactic trees, semantic denotations or even higher-level discourse structure. Constructing alternative sets may also involve more domain-general knowledge, such as conceptual or world-knowledge. Alternatives might be derived in the processing of focus using all of the above types of information, or based on some combination of them.

This question about the nature of the mental representations is not specific to comprehension of focus, but is prevalent throughout the study of discourse processing. Many processing theories of discourse comprehension make reference to various representations of the discourse context itself, and it is still an open question which representations are the right ones for which phenomena. Crucially, what kind of representations are targeted by these computations also determines what type of information they are sensitive to. For focus the question is what constrains the search space for contrastive alternatives—i.e., whether besides lexical, conceptual and general world-knowledge, comprehenders are also guided by syntactic, semantic, or other grammatical factors at all in the construction of alternative sets.

Based on intuitive judgments, there is reason to assume that simply mentioning expressions is not enough for comprehenders to also encode them as alternatives. Mention of a potential alternative is also not sufficient in guiding focus assignment. Consider the narrative in (17), for instance, in which the expressions *penguins* and *whales* could be considered viable alternatives to the subsequent expression *bats*, but this narrative does not give rise to

the intuition that *bats* alone is being contrasted with these potential alternatives and is focus marked here.

- (17) a. On Saturday, Sarah had a busy day, she first did some shopping before going to the zoo with her niece to see the new penguins and whales they recently acquired.
- b. But on Sunday, she wanted to take things easy and only [read a book about bats]_F

Mention of (multiple) alternatives to a possible focus does not set up the relevant alternative set such that focus is also assigned accordingly, at least not in the final interpretation of such foci. Intuitively, what is relevant for an expression to trigger the encoding of a particular alternative set is some notion of *contrast*. For instance, the narrative in (17) is intuitively about things that Sarah did during the weekend: shopping, going to the zoo, and reading a book. This is why it is perhaps more likely for readers of this narrative to draw the inference that Sarah did not do anything else besides reading a book on Sunday (instead of drawing the inference that she did not read books about alternatives to bats).

Below, I argue that the relevant notion of contrast must be able to make reference to, at least, (i) the possible replaceability of expressions within the sentence context, (ii) larger pieces of linguistic structure than single words, and (iii) the entailments established in the preceding discourse. More generally, throughout Chapters 3-5, I show that the relevant representations involved in ①-③ are abstract, in the sense that they pertain to semantic information provided in discourse, not just to representations at the level of linguistic surface structure.

2.4.1 Probing mental representations using reading measures

2.4.1.1 Chapter 3

In Chapter 3, I show that constructing the alternative set based on context must be sensitive to some notion of replaceability of an alternative with the focus. This is because mention of expressions that could replace the focus, as in (18a), facilitates processing of a downstream focus more than the presence of lexical material that is closely related to the focus but cannot replace it, as in (18b).

(18) I heard there will be some changes in the sales contract. . .

- a. **Context A:** ...will they stop selling cigarettes at the corner store? ALT
NON-ASSC
- b. **Context B:** ...what did you hear from the reporter? NON-ALT ASSOC

Target: I think I heard it was [newspapers]_F that they will stop selling at the corner store,...

① → ② → (3)

In the proposed framework, we can understand this facilitatory effect of explicitly mentioned replaceable expressions as stemming from the fact that a dependency between the focus and its context is easier established in (18a) than in (18b) because a potential alternative is contrasted with the focus in the first case ((3)) but not in second case ((3)). In order to determine whether an expression is a viable alternative to the expression in focus, comprehenders must thus, minimally, be able to reason about whether an expression could felicitously replace that focus within the broader sentence context. This involves, minimally, that comprehenders retrieve this expression such that they can then reason about replacement.

2.4.1.2 Chapter 4

In Chapter 4 I show that the assignment of focus marking can take place either based on the presence of explicit preceding questions, as in (15), or based on the presence of a semantic contrast that is established in the discourse. In this chapter I study the assignment of focus for foci larger than a single word, and I show that in these cases too, focus can be reliably assigned based on alternatives in the preceding context. This suggests that the relevant notion of contrast must be able to make reference to larger pieces of linguistic structure. After all, in establishing a contrast between two or more alternatives that are larger than a single word, the individual subconstituents that make up these alternatives must also contrast with each other.

For instance, (19a) establishes a contrast between *whales* and *penguins*, while (19b) establishes a contrast between *a book about whales* and *a report about penguins*. But in both (19a) and (19b), the words *whales* and *penguins*, which would be viable alternatives to *bats* in the subsequent target sentence, are mentioned. Despite this, reading times obtained on this target sentence suggest that focus marking is assigned to the entire phrase *books about bats* when that sentence is preceded by (19b), while focus marking is assigned only to *bats* when preceded by (19a).

- (19) a. **Context A:** Lily read a book about whales and penguins, ... NARROW
 b. **Context B:** Lily read a book about whales and a report about penguins, ...
 WIDE

Target: ...but Sarah only read [_B a book about [_A bats]_F]_F,...

In order to correctly assign focus to larger phrases, it must be the case that comprehen-

ders only take into account the largest possible contrast that is signaled by the preceding discourse. And therefore, mention alone is not sufficient to trigger the encoding of an alternative set. At the very least, some notion of semantic contrast beyond mention of individual linguistic expressions is necessary to explain the way focus is assigned in these cases.

2.4.1.3 Chapter 5

Results from Chapter 5 show that constructing the alternative set based on context must involve contextual information which involves, at least, some representation of the entailments that are established in the discourse. In these experiments, reading times were measured on alternatives that followed a focus, as on *cheese* in (20).

- (20) a. **Context A:** The tourist asked for a variety of items, like an ashtray and some milk. There was already some cheese on the table. TARGET ALT EXCL.
- b. **Context B:** The tourist asked for a variety of items, like some cheese and some milk. There was already an ashtray on the table. TARGET ALT NON-EXCL.

Target: When the waiter returned, he remembered to bring only milk,

but no **cheese** to the table where...

② →

① → ③ → ②

Slowdowns were observed on mentioned alternatives that are excluded as a relevant alternative to the focus *milk* by the context. For instance, in (20a), *cheese* may not be considered a relevant alternative to *milk* because it is not among the things that were asked about, and is therefore unlikely to be among the things the waiter could have remembered to bring.

The slowdown on such contextually excluded alternatives was not observed in the ab-

sence of *only* in the target sentence, indicating that this effect, too, can be explained in terms of the processes in ①-③: If the processing of the preceding focus involves the computation of the appropriate alternative set, and in constructing this alternative set, readers are sensitive to inferences that are established in the discourse context, then it would be expected that reading of a subsequent expression that is part of the alternative set is facilitated over reading of an expression that is not a viable alternative. Again, this also suggests that mention of linguistic expressions is not enough for them to also be considered contextually relevant alternatives, because mentioned expressions may still be incidentally ruled out as alternatives to the focus based on contextual information.

Together, these chapters show that the relevant contextual information for ①-③ is in some sense abstract, because it involves semantic information provided in the discourse that stems from larger pieces of linguistic structure, not just from lexical or conceptual representations that comprehenders may generally have access to.

2.5 Conclusion

In this chapter I argued that the processing of focus is complex, in the sense that it consists of several subprocesses that are both interdependent and dependent on external information. Under the view I sketched here, the amount of resources necessary for the comprehension of focus is context-dependent, because which of these processes is carried out when generally depends on the amount of information comprehenders have at their disposal. This dissertation studies the time-course of these processes, because it can tell us how the mental representations involved in each of these subprocesses are constructed in real-time comprehension. It also studies what type of information these subprocesses are sensitive to, because this can shed light on what information is encapsulated in these mental

representations. This view on focus processing also has several additional consequences that may be useful in understanding the relationship between the behavioral signature of focus and its formal representations.

First, since this view entails that it is the abstract representation of focus marking itself that has important consequences for the comprehension of discourse—and not just the introduction of new/important information—it makes testable predictions for ways in which effects of newness/givenness can be disentangled from effects of focus marking. This dissertation tests some of these predictions and shows that the behavioral signature of focus marking can indeed be empirically separated from that of newness, suggesting that focus itself induces a general cost that cannot be attributed to a cost for interpreting new information.

Similarly, it allows us to think about the effect of prosody as potentially separable from, but related to, the assignment of focus marking. In this view, prosody may signal the presence of a particular underlying focus structure, but the processing of focus involves more than comprehenders dealing with (implicit) prosodic representations. Again, this correctly predicts that focus marking may have ramifications for sentence processing even when foci are not prosodically prominent.

Third, this view is able to explain why the reading literature on focus has found such mixed results, because it suggests that foci induce a lower cost when they are given and when information about the alternative set is provided in the context. More generally, it provides a more unified understanding of the behavioral effects obtained for foci throughout psychology and psycholinguistics, because it allows us to better understand why foci can be anticipated in some cases, requires more processing resources in other cases, and may involve, in all instances, the (re-)activation of contrastive alternatives.

Finally, this view also helps gain traction on understanding what kind of representations comprehenders rely on in structuring the information in discourse more generally. This view allows us to ask specific questions about the way in which these processes depend on context, what information is encoded when and how such representations may be maintained and updated over time. And because the processing of focus can be used as a window into the way in which contextual information is utilized by comprehenders to anticipate upcoming linguistic structure, the findings presented in the chapters to follow also allow for a more fine-grained understanding of the notion of predictability in discourse. Together, these findings suggest that what makes an expression predictable in a given context depends on discourse-specific information that is more abstract than representations of lexical knowledge or linguistic surface form.

Chapter 3

Processing of focus depends on contrastive alternatives

3.1 Introduction

The goal of this chapter is to lay the groundwork for an understanding of focus processing in which its comprehension depends on the computation of contrastive alternatives. This chapter will test the predictions of the view on focus processing outlined in Chapter 2, in which the process of interpreting a focus was argued to consist of the four subprocesses in (1), and the cost of interpreting any particular focus was argued to depend on the time-course at which these processes are completed as well as the amount of information available in the discourse context.

(1) **The subprocesses of focus comprehension**

- ① Assignment of focus
- ② Constructing the alternative set
- ③ Establishing a dependency with context

④ Incorporating alternatives into sentence meaning

This chapter aims to motivate this view on focus processing by showing that it can account for the fact that studies that have investigated the processing of linguistic focus by monitoring eye movements during reading have found mixed results. Some have reported a decrease in reading times on focused material (Morris & Folk, 1998; Birch & Rayner, 2010), while others observed an increase in reading times (Birch & Rayner, 1997; Benatar & Clifton, 2014; Lowder & Gordon, 2015). Explanations for the differences in these effects have acknowledged that focus is a complex construct and that its effects are likely to be modulated by many factors. For example, focus often covaries with informational newness; foci are frequently prosodically prominent; and a word or phrase can be focused using a variety of different syntactic constructions, which have their own specific properties and may require different resource allocations. However, as outlined in Chapter 2, focus and givenness/newness are conceptually distinct categories, and may therefore in principle have distinct behavioral signatures. Similarly, not all focused material also receives prosodic prominence in all cases. In the previous chapter I argued that the lack of a unified understanding of the inconsistencies in the reading literature is due in part because effects of focus have not been successfully disentangled from effects due to other factors such as newness or prominence.

This chapter therefore reports four experiments that clarify how these different factors modulate the processing of focus. Experiment 1 showed slowdowns on foci even when those foci were not new information, demonstrating that focus slowdowns cannot be reduced to the cost of incorporating new material. Instead, there must be a cost for processing focus itself, in line with the results of Benatar & Clifton (2014), Birch & Rayner (1997),

and Lowder & Gordon (2015). In order to clarify why some previous studies also found speed-ups on target foci (Morris & Folk, 1998; Birch & Rayner, 2010), Experiments 2 and 3 manipulated the presence or absence in the context of *contrastive alternatives* — linguistic expressions which could have taken the focus’s place. Using either a focus particle (*only*) or a cleft construction (*it was the...*), these experiments showed a reduction of the focus slowdown in the presence of contextually mentioned alternatives. Experiment 4 demonstrated that this facilitatory effect of contrastive alternatives cannot be reduced to an effect of simple semantic associate priming. Alternatives that were not close semantic associates of foci attenuated the focus slowdown more than close semantic associates that were not alternatives. Together, these findings indicate that a comprehensive theory of the processing of focus must incorporate the concept of contrastive alternatives, as well as an explanation for their systematic interactions with newness (Experiment 1), different focus constructions (Experiments 2 and 3), and semantic association (Experiment 4). I argue that the understanding of focus processing proposed in Chapter 2 provides such an explanation, because it suggests that focus marking induces a general processing cost, which is empirically separable from that of newness, and which stems, at least in part, from the way contrastive alternatives are involved in different focus constructions.

All four experiments in this chapter (as well as those in Chapter 4 and 5) were run using the Maze task (Forster et al., 2009), due to the global Covid-19 pandemic. In this task, readers progress through a sentence by choosing which of two presented words is the most suitable continuation of the sentence up to that point. Such a decision can only be made if preceding material is sufficiently incorporated in the reader’s representation of the sentence. This task is less prone to spillover effects than alternative tasks, such as self-paced reading (Witzel et al., 2012). Moreover, decision times in the Maze have been

shown to correlate with total reading times (the sum of all fixations on the target region) obtained by monitoring eye movements during naturalistic reading (Forster et al., 2009), the originally-intended method. While a close comparison with previous studies was lost, this change in method does allow conceptual replications of findings from the earlier literature to demonstrate the robustness of those effects across tasks, and so may increase our confidence in those effects' generality beyond task-specific conditions.

The rest of this section describes the earlier findings from eye movement data, and motivates Experiment 1 by explaining the need for a study that manipulates newness independent of focus, using question/answer pairs and without changing the sentential position of focused words across conditions. In subsequent sections, a systematic review of the findings from eye movements during the naturalistic reading of linguistic focus reveals that the only studies that reported speed-ups in the processing of foci were ones in which a contrastive alternative to a focus was presented before that focus was encountered. This motivates Experiments 2-4 which manipulate the presence of contrastive alternatives in the context to probe the effect such alternatives have on the reading of a subsequent focus.

3.1.1 A proposed role for newness

The most detailed proposal about the comprehension of focus in sentence processing was put forward by Benatar & Clifton (2014). They suggested that, while many factors seem to cooccur with focus, the distinction that best captures the processing of focus is the dimension of newness versus givenness of information. Information is *given* if it is semantically entailed by what has come before in the discourse; all information that is not given is *new* (Schwarzschild, 1999). New information would be expected to require more effort to process than given information, because that new information has not already been

integrated into a comprehender's understanding of the world. This might explain the longer reading times on foci than non-foci that Benatar and Clifton and others found. If new information is always in focus, then any slowdown on foci might be attributed to their status as discourse new.

Under Benatar and Clifton's newness/givenness-based proposal about focus processing effects, the studies which instead found *shorter* reading times on focused words (Birch & Rayner, 2010; Morris & Folk, 1998) may have done so for a variety of reasons. Perhaps these shorter reading times were found because these studies compared foci that occurred later in sentences with baseline words that occurred earlier, and so natural oculomotor differences in reading the positions of words on a line caused foci to be read more quickly. Perhaps these shorter reading times were found because these studies provided greater contextual support for the focus-containing target sentence, in the form of a preceding context sentence. Or perhaps these factors interacted with the syntactic devices that were used to focus words in these studies: all of them used clefts (*It was...that...*), which introduce extra inferences into sentence comprehension. For these reasons, the best study under this account would: (i) hold target sentences constant across conditions, (ii) provide stable contextual support for all target sentences, and (iii) use questions to manipulate the location of focus as the part of an answer target sentence that provided the asked-for information, so that the focus manipulation did not introduce extra inferencing during the processing of the focused word.

Benatar and Clifton's studies accordingly compared new focused with given non-focused target words. Sentence position and inferencing requirements were equalized across conditions by employing question/answer pairs and holding target sentences constant within each item. In their first experiment, target sentences were answers to preceding questions.

The baseline condition consisted of completely given information, as in (2a), in which the preceding context question introduced both the existence of the characters and their possible relationship. In test conditions, longer reading times were then observed on target focused words, such as *Natalie*, when either the information about their relationships were new (here, the information that Kyle cared about Natalie) but the target word itself was not, as in (2b), or when the target word was entirely new, as in (2c). This held for first fixations (i.e., duration of the first fixation on a word during the first pass through the text), gaze durations (i.e., the sum of all first-pass fixations on a word), and total reading times.

- (2) a. A: I'm confused, does Kyle care about Natalie?
 B: Kyle cares about **Natalie**, but he doesn't show it. given
- b. A: Natalie is confused, does Kyle care about someone?
 B: Kyle cares about **Natalie**, but he doesn't show it. new, rep
- c. A: Isabella is confused, does Kyle care about someone?
 B: Kyle cares about **Natalie**, but he doesn't show it. new, no rep

This pattern of longer reading times in (2b) and (2c), which both contained new information pertaining to the focused word, than (2a), which contained only given information pertaining to the focused word, was interpreted as support for Benatar and Clifton's account.

3.1.2 Separating sentence position from focus construction

Support for the suggestion that sentence positional differences contributed to the findings of shorter reading times on foci was found by Lowder & Gordon (2015), who demonstrated that longer reading times on focused material generalize to syntactically-focused pseudoclefts (e.g., *what the secretary typed was...*). This construction permitted control of

the sentence position of target words across conditions, something which had been lacking in the earlier studies that used simple clefts (*it was the...*) and found shorter reading times on foci (Birch & Rayner, 2010; Morris & Folk, 1998). A sample item from Lowder and Gordon's study is shown in (3).

- | | | | |
|-----|----|---|---------|
| (3) | a. | What the secretary typed was the official memo about... | focus |
| | b. | Yesterday the secretary typed the official memo about... | neutral |
| | c. | It was the secretary that typed the official memo about... | defocus |

Lowder and Gordon found longer reading times on focused target words as compared to defocused target words (which were defocused, because another word in their sentences were overtly focused) in both gaze durations and regression-path durations (i.e., the sum of all fixation durations on a region before exiting the region to the right). But they were further able to demonstrate that as target words became more focused — that is, comparing reading times in order across (3c), (3b), and (3a) — reading times increased. This increase with degree of focus supports the suggestion that variation in the effect sizes observed in previous work could also have been due in part to the differences in baseline conditions that were employed, i.e., neutral vs. non-focused.

3.1.3 A possible role for contextual support

Lowder and Gordon's results clarified that the effect of syntactically-cued focus is one of longer reading times once sentence position is controlled. But differences in sentence position between foci and non-foci could not, by themselves, account for the difference between Birch and Rayner's (1997) finding of longer reading times on foci than non-foci versus Birch and Rayner's (2010) finding of *shorter* reading times on foci than non-foci.

Birch and Rayner's (1997) first experiment employed both new foci and new baselines, as shown in the sample item in (4), where *suburb* was the target word that was compared across conditions and in neither condition was it mentioned before or entailed by anything preceding it. Birch and Rayner (1997) found longer second-pass reading times on foci and greater probability of regression from foci than non-foci, even though *suburb* was newly mentioned in both conditions.

- (4) a. It was the **suburb** that received the most damage from the ice storm. focus
b. Workers in the **suburb** hurried to restore power after the ice storm. non-focus

This pattern of longer reading times contrasted with the findings of Birch and Rayner (2010), who used the same cleft focusing structure as Birch and Rayner (1997), but with a context sentence presented before each one, as in their item shown in (5).

- (5) Context: The tenants at the complex were sick and tired of all the noise coming from #204.
a. It was the **landlady** who confronted the woman who lived there. focus
b. The **landlady** confronted the woman who lived there. non-focus

It thus seems that contextual support played a role in Birch and Rayner's (2010) findings of shorter reading times on foci versus non-foci, but this property may not have held of Morris and Folk's (1998) stimuli, which were not preceded by separate context sentences, but nonetheless yielded shorter reading times on foci. An example item from Morris and Folk's study is shown in (6), in which the target word *accountant* was compared across conditions. Notably, Morris and Folk's conditions compared *accountant* in focus and *de-*

focus, that is, with a different word from accountant in the syntactically focused position in (6b), unlike the simple declarative sentence with no special focus on the target word that served as a baseline for Birch and Rayner.

- (6) a. While the waiter watched, it was the **accountant** who balanced the ledger a second time. focus
- b. It was the waiter who watched while the **accountant** balanced the ledger a second time. defocus

It would be surprising if Morris and Folk's items provided enough contextual support to facilitate the processing of their focused words, but Lowder and Gordon's items did not. The pseudocleft structure employed by Lowder and Gordon likely provides more contextual support before its focus than a simple cleft; in the case of the sentence beginning *What the secretary typed was the official **memo** about...*, for example, a secretary typing was already introduced before the focused word *memo*, making that focused word much more expected in context than if it were early in the sentence and out-of-the-blue. Longer reading times on focused *memo* in Lowder and Gordon's study would be mysterious under an account which appealed to contextual support to explain the shorter reading times on foci that previous studies had found. If newness is the primary driver of focus processing costs, but it can be overcome by contextual support for focused words, then Lowder and Gordon's effects might be expected to be more like Birch and Rayner's (2010) and Morris and Folk's (1998) pattern of shorter reading times on clefted foci with contexts, instead of Birch and Rayner's (1997) pattern of longer reading times on clefted foci without contexts. I take up the question of why Morris and Folk (1998) and Birch and Rayner (1997) found speed-ups again in the conclusion of this chapter (see 3.7).

While Lowder and Gordon agreed with Benatar and Clifton that focus is a complex conjunction of many different properties, they suggested that focused material generally is more deeply encoded than non-focused material, with more effort expended to integrate it during language processing due to its greater importance in its sentences. This greater effort expended on focus would be expected to require more time, and would account for why focused material is advantaged in other tasks, for example, it is reliably better remembered than non-focused material (Birch & Garnsey, 1995b; Gernsbacher & Jescheniak, 1995; McKoon et al., 1993; Singer, 1976). In principle, Lowder and Gordon's suggestion is not logically incompatible with the proposal that the processing profile of focus is generally due to a greater cost of processing new versus given material. But their pattern of longer reading times on foci with greater contextual support when newness was a property of both foci and baselines is not straightforwardly explained under Benatar and Clifton's proposal.

3.1.4 Manipulating focus independent of newness

There is a test case which would separate Lowder and Gordon's account of the focus cost as due to general deeper processing from Benatar and Clifton's proposal that the focus cost is largely due to the cost of new information. As has been noted in the theoretical literature, the notion of focus is conceptually distinct from that of newness/givenness and therefore, material can receive focus marking without being discourse-new (see Chapter 1 for more details). If focus effects are generally reducible to the newness/givenness distinction, then longer reading times for focused material than non-focused material when both the focus and its comparator non-focus were given would be unexpected (in the absence of confounding factors like different sentence positions between focus and comparator or the introduction of extra inferences by a specific focusing structure). In contrast, Lowder

and Gordon's proposal that focused material is simply more deeply encoded and effortfully processed than non-focused material would account for longer reading times on focused material even when both are given and all else is held equal. This motivated the present Experiment 1, in which a full cross of givenness versus newness and focused versus non-focused targets was tested.

Results of this experiment showed that comprehenders take longer to respond to given foci than comparable given non-foci. Since focus thus slowed down reading even when given, these results indicate that explanations of the focus slowdown cannot solely appeal to newness. Results from Experiment 2-4 showed that the focus slowdown was modulated by contextual mention of contrastive alternatives, suggesting that, instead of newness, it is the alternative-generating nature of focus that must at least in part affect its reading profile.

3.2 Experiment 1

In Experiment 1, two factors — focus (focus vs. not) and newness (given vs. new) — were fully crossed, with focus controlled by preceding questions, which do not introduce the kind of extra inferences that clefts as focusing devices do. This provided a test of whether focus has an effect on reading in the absence of newness, an outcome that would not be expected if the cost of focus processing is generally due to the cost of integrating new material. This was the first study to compare focus and baseline conditions that were both given information.

3.2.1 Method

Participants 51 participants were recruited via the Prolific platform for web-based research and were paid a \$12 hourly rate for their participation. All participants were native

speakers of English and gave explicit consent to participate. Participants who had an accuracy of less than 80% on the comprehension questions or that did not complete more than 70% of the Maze sentences were excluded from analysis. Data from 48 participants were included in the analysis; 3 participants were excluded because they failed to complete more than 70% of the Maze sentences.

Materials In all the experiments presented here, every item took the form of a short dialogue between two speakers, Speaker A and Speaker B. Speaker A first introduced a short premise, followed by a question. Speaker B's utterance formed a response to the question from Speaker A. Speaker A's utterance was considered the context sentence and was presented all at once on a single screen; it then disappeared when participants advanced to the next part of the trial. Speaker B's utterance was considered the target sentence and was presented using the Maze task. Within one item, the same sentence was the target for every condition, in order to ensure that differences across conditions would only be due to preceding context sentences. Within each target sentence, measurements on a single target word were expected to particularly reflect the effects of preceding contexts.

Preceding context questions determined whether a target word was NEW or GIVEN by either mentioning that target word in the question or not. Orthogonal to this manipulation of newness, preceding questions determined whether target words received narrow focus (NF) or broad focus (BF) by asking for differently specific information. Narrow focus questions were ones to which a following target word on its own would provide a complete answer; broad focus questions were ones to which a target word alone would not seem a complete answer. We employ the distinction between narrow and broad focus, rather than the distinction between focused and neutral words, because focus in this study is manipulated by which parts of a target sentence provide the answer to a question. Our narrow versus broad

focus conditions are analogous to Lowder and Gordon’s (2015) focused versus neutral conditions. Here, the narrow versus broad distinction captures Lowder and Gordon’s point that differences in degree of focus matter; the degrees of focus in the answers to questions can be understood as the proportion of the focus of a sentence that single word encompasses. In narrow focus conditions, the single focused word would be a complete answer to a preceding question and is the entirety of the focus. In broad focus conditions, the words that must be included in the focus are more numerous; in the case of these stimuli, they are the entirety of a phrase. This is illustrated in the example experimental item shown in (7) below. In (7), the target word is *lawyer*.

(7) **Speaker A:** This company often makes bad decisions, but...

- | | | |
|----|---|-----------|
| a. | Did they hire a lawyer last fall, or an <u>accountant</u> ? | NF, GIVEN |
| b. | Did they hire a lawyer last fall? | BF, GIVEN |
| c. | Did they hire an <u>accountant</u> last fall? | NF, NEW |
| d. | What did they announce last time? | BF, NEW |

Speaker B: I think they announced they hired a lawyer last fall,

but I’m not sure.

In response to narrow focus questions, as in (7a) and (7c), *lawyer* would be a complete answer. Across all items, for creating narrow focus and givenness on the target word, alternative questions were used (i.e., questions in which two alternatives are given in the form of a disjunction). Since the answer to such a question is expected to be one of the mentioned alternatives, the answer was either *accountant* or *lawyer* in the case of (7a). Therefore, the questions in the NF GIVEN conditions put only the target word *lawyer* in

focus in the target sentence.

The NF NEW items always employed polar questions (i.e., questions whose expected answers are either confirmative or negative) that mentioned a different alternative from the one mentioned in the target sentence. The target sentence would therefore be unambiguously interpreted with corrective narrow focus on the target word.

After broad focus questions, *lawyer* in the target sentence would be part of a larger focused phrase, because a whole phrase from the target sentence would be required in order to provide a complete answer to the preceding questions. The BF GIVEN condition always used polar questions as well, but in these questions the alternative was the same as in the target sentence. This puts the target sentence as a whole in broad focus, as is the case in (7b). This had the result that both the wh-question in (7d) and the polar question in (7b) put at least the whole phrase *they hired a lawyer last fall* in focus, because this is the phrase that forms a congruent answer to each of these questions. Although it would be less natural, it is still technically possible that (7b) could be interpreted with narrow focus on the target word; there is nothing that *prevents* a reader from interpreting this as a narrowly focused phrase. However, evidence from interpretation and completion studies supports the assumption that comprehenders default to the broadest possible focus that is supported by the context (Harris & Carlson, 2014, 2017); this accords with theoretical semantic assumptions as well. But, even assuming that narrow focus is more costly than broad focus, and that a narrow focus parse was maintained in at least some of our items' broad focus given conditions, the estimated effect of focus from our study would be, if anything, slightly diminished and so decrease the likelihood that we would find an effect of focus in given conditions, because we expect narrow focus to be more costly to process than broad focus.

It is worth addressing a concern raised by an anonymous reviewer of an earlier version of this work: in order to manipulate newness/givenness in these stimuli, more material immediately before the target word was repeated in the given conditions (7a) and (7b) than in the new conditions (7c) and (7d). Any potential effect of the newness/givenness difference in these stimuli was thus perfectly confounded with repetition differences, with the result that expected shorter response times on given conditions relative to new conditions could be due to the simple repetition effects; this was the problem that led Benatar and Clifton to adopt hypernyms in their second experiment. This inherent covariation of the newness/givenness distinction with repetition in our items was not a confound for the particular effect that this study seeks to demonstrate: the presence of a focus effect even when *both* a focus and its non-focus comparator are given. The present study employed simple repetition to manipulate givenness because repeating material is the most straightforward and the most unambiguous way to make material discourse given. In this study, the goal was to show that *given* foci indeed slowdown relative to *given* non-foci, while we were less interested in the givenness effect itself. It was therefore crucial that given material was indeed undeniably given, which was most easily obtainable if both conditions involved repetition. Since it is pragmatically marked to use a different term as the one that is already established in the context to refer to an individual, the use of a synonym could always be interpreted as introducing new, contrastive information.

In each item, the target word was always followed by an adverbial phrase (*last fall*) which served as a spillover region. This spillover region was also always followed by a second clause (*but I'm not sure*), to ensure naturalness of the target sentence in the BF GIVEN condition.

In total, 48 items were constructed, each with the four conditions illustrated in (7). All

items for Experiment 1 can be found in Appendix II; these were first tested in an acceptability judgment study, the results of which can be found in Appendix I. Another 96 filler items which also consisted of multi-line discourses were interspersed with test stimuli. Using a Latin Square design, all 48 items were counterbalanced over 4 lists, such that each participant saw one condition from every item.

Procedure The Maze task is similar to the more commonly used self-paced reading task in that response times are measured using button presses. But instead of simply pressing a button to advance to a following word each time a participant has read the current word, participants in the Maze task see each word in the target sentence presented alongside a distractor word (or *foil*). Participants must at every new word choose the correct continuation between the intended item and its foil, which would not make a sensical continuation.

Foils were automatically generated using the AutoMaze software developed by Boyce, Futrell, and Levy (2020). This algorithm selects distractor words that are of the same length as the target word, and that are predicted by NLP language models to have a poor fit to the preceding sentence material. For each upcoming word, a conditional probability distribution is determined for potential foils of the same length in the context of the preceding sentence. The words with a predicted probability below a certain threshold (or, *above* a certain *surprisal* threshold) are then selected by the AutoMaze algorithm as the distractor. Word frequencies that form the input to these models are obtained from the Google Books Ngrams corpus (Michel et al., 2011).

An example of the AutoMaze output for one target sentence is given in (8) below. On the second line, the distractor word is presented below its corresponding word of the target sentence.

- (8) I think Sarah said she wanted cake for dessert, but I am not sure.
x-x-x goods Runes blue sum bottom knee sum classed, tax Sin far sat send.

In this way, sentences were presented incrementally, and the response time required to make and execute a decision about which word should continue a sentence was measured.

On every trial, participants first read a context sentence on one screen. On a subsequent screen, participants were presented with the start of the target sentence in the format of the Maze task. That is, only the utterance of Speaker B was presented incrementally; the utterance of Speaker A was presented all at once for normal reading. The context sentence disappeared from the screen when participants moved on to the target sentence. All experimental trials were followed by a comprehension question, which probed whether participants had read the context preceding the target sentence. This was because there was more cause for concern that participants might not read the contexts than that they might not read the target sentences. Participants had to read the beginning and all subsequent material of a target sentence in order to even make a decision about which word could form a potential continuation as the sentence went on. If they chose the wrong word in the Maze task, they were directed to the next item and their responses on the rest of the words in the target sentence were not recorded. But participants could successfully go through a whole target sentence in the Maze without having read its preceding question, and so comprehension questions were included after each trial that encouraged careful reading of the preceding context. For instance, the example item in (7) was followed by the comprehension question in (9).

- (9) Is the company known for its strategic actions?

Before being presented with the target stimuli and fillers, participants read a short descrip-

tion of the task, followed by five practice items. Practice items were similar to experimental items in that they involved a short context sentence, followed by a sentence presented in Maze format and a comprehension question. After the short practice phase, the experimental items were presented along with the fillers in a pseudo-random order.

Analysis Data were analyzed using R, version 3.6.3 (R Core Team, 2021). We fit Bayesian (generalized) linear mixed-effect models using Stan, as implemented in the brms package, version 2.18.0 (Bürkner, 2017), with the default priors. Separate models were fit to log-transformed response times and untransformed response times as dependent measures. For each model, we ran four chains, each with 5000 steps (warmup = 1000 steps). Rhat statistics in all models approached 1.00 and no warnings emerged. Models included population-level effects of focus and newness (deviation-coded), with broad focus and given conditions treated as reference levels, and random slopes and intercepts for both subjects and items (Baayen et al., 2008).

3.2.2 Results

Mean response times for the target word and its surrounding regions in all conditions are given in Table 3.1. They are plotted with 95% confidence intervals in Figure 3.1.

The mean comprehension question accuracy was 88%, and the mean completion rate of the maze target sentences of Experiment 1 was 87%.

Tables 3.2 and 3.3 present the fixed effects estimates for the models of Experiment 1 log-transformed response times and untransformed response times on target words, respectively. Both models found two reliable effects. First, positive estimates of focus indicate that targets in narrow focus were responded to more slowly than targets that were part of a broad focused phrase. Second, positive estimates of newness indicate that responses were slower

Condition	Previous -1	Previous	Critical region	Spillover	Spillover +1
NF (ALT), GIVEN	686.71 (9.33)	643.62 (7.87)	774.52 (11.62)	741.49 (10.10)	711.16 (11.63)
BF (NO ALT), GIVEN	720.57 (11.53)	664.96 (8.81)	724.32 (10.66)	736.01 (11.00)	701.30 (10.12)
NF (ALT), NEW	732.08 (12.91)	663.40 (8.42)	952.54 (15.64)	790.33 (12.16)	718.12 (11.38)
BF (NO ALT), NEW	893.66 (17.01)	745.91 (11.08)	937.43 (15.83)	867.97 (15.97)	770.00 (13.22)

Table 3.1: Experiment 1: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

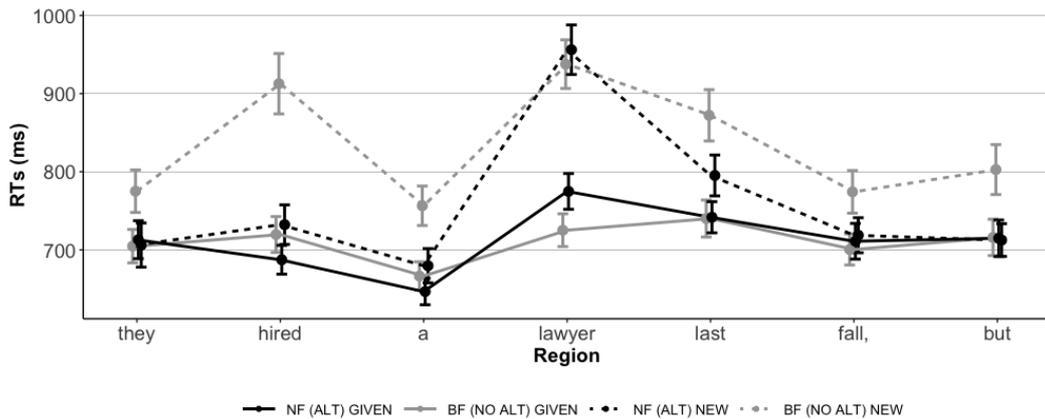


Figure 3.1: Experiment 1: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

in the new conditions compared to the given conditions. The interaction estimates were not reliable because their credible intervals overlapped with zero in either model. Pairwise comparisons revealed that narrow focused given target words were responded to more slowly than broad focused given target words, for both log-transformed ($\beta = 0.03$; $95\%Cr.I = [0.02, 0.04]$) and untransformed ($\beta = 49.57$; $95\%Cr.I = [18.06, 81.06]$) response times.

On the word following the target word, models revealed a main effect of newness, focus and a reliable interaction between newness and focus. Pairwise comparisons revealed that the focus effect was reliable in the new conditions ($\beta = 0.036$; $95\%Cr.I = [0.015, 0.060]$), but not in the given conditions ($\beta = -0.004$; $95\%Cr.I = [-0.021, 0.014]$).

		Estimate	Est.Error	95%CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
ROI	(Intrcpt)	2.90	0.01	[2.88, 2.93]	1.01	710	1332
	Focus	0.02	0.01	[0.01, 0.03]	1.00	3261	3105
	Newness	0.09	0.01	[0.08, 0.11]	1.00	2200	2972
	Foc:New	-0.02	0.01	[-0.04, 0.01]	1.00	4319	3437
ROI+1	(Intrcpt)	2.87	0.01	[2.85, 2.90]	1.00	650	1308
	Focus	-0.02	0.01	[-0.03,-0.00]	1.00	3925	2770
	Newness	0.04	0.01	[0.03, 0.06]	1.00	2058	3031
	Foc:New	-0.04	0.01	[-0.06,-0.02]	1.00	5505	3224

Table 3.2: Posterior estimates for population-level effects in Bayesian mixed effects model of LogRTs in Experiment 1.

		Estimate	Est.Error	95%CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
ROI	(Intrcpt)	847.39	23.17	[799.79, 892.14]	1.00	1084	1627
	Focus	35.28	17.50	[0.71, 69.56]	1.00	3371	3190
	Newness	195.64	21.25	[153.73, 237.45]	1.00	1876	2633
	Foc:New	-28.53	29.70	[-88.53, 27.88]	1.00	4348	3534
ROI+1	(Intrcpt)	786.18	21.64	[742.21, 828.78]	1.00	1202	1686
	Focus	-37.82	15.30	[-67.97, -7.40]	1.00	4016	3093
	Newness	91.47	17.57	[56.91, 126.83]	1.00	2167	2792
	Foc:New	-78.25	25.64	[-127.96, -28.00]	1.00	4611	3566

Table 3.3: Posterior estimates for population-level effects in Bayesian mixed effects model of raw RTs in Experiment 1.

3.2.3 Discussion

In addition to being affected by newness versus givenness, response times on the target word in Experiment 1 also depended on whether the target word was in narrow or broad focus. Most importantly, comparing only target words that were given, response times were longer when targets were narrowly focused than when they were only a part of a broadly focused phrase. This is unexpected if focus effects were primarily driven by the newness/givenness difference in the absence of either inferences demanded by syntactic constructions or the contextual support provided by preceding material. The stimulus sentences of the present study held the target sentence identical across all conditions, and so no condition's target sentence introduced meaning inferences that the others' did not. All

of the conditions were preceded by a question which contained much of the same linguistic material in the target sentence, thereby providing contextual support for the target word in narrow focus.

However, perhaps one intuitive way to account for these findings that does not make direct reference to focus marking itself is to say that the focused material in these stimuli, though given, still corresponded to material that was unpredictable or unrecoverable given the previous context. At least intuitively, this is because the questions in the Experiment 1 NF GIVEN conditions always contrasted two alternatives and target sentences then answered these questions by stating which alternative was true. More generally, a hypothesis along these lines has been echoed throughout the literature on focus processing (Cutler & Fodor, 1979; Lowder & Gordon, 2015; Benatar & Clifton, 2014), but in order to find evidence for or against such a hypothesis it is useful to be precise about the exact notion of predictability here.

For instance, this notion of predictability cannot correspond to any type of lexical predictability, because the lexical material used in the target sentences was identical across conditions, and this lexical material was always also present in the preceding question. Similarly, when stated in terms of cloze probability—i.e., the probability that material in the target sentence would be used in a cloze task—the focused phrases would most likely receive relatively high scores. This is exactly because the alternative questions that were used to manipulate Focus are typically interpreted as allowing only the two provided disjuncts as their possible answers, thus presumably giving rise to cloze probabilities for each focused phrase of around 0.5. Indeed, in the GIVEN NF conditions, the preceding questions provided more contextual support than in the GIVEN BF conditions, because the narrow focusing questions also provided an alternative to the target word. Nonetheless, participants

took longer to respond to the *given nf* target word than the *given bf* target word, exactly the opposite of the pattern predicted by an account appealing to this notion of predictability to explain these findings.

Instead, in order to explain the slowdowns on given foci we need to somehow make reference to the meaning of these questions: foci corresponded to material that provided the answer to the preceding question, and can therefore be thought of as most unpredictable in the sense that it expressed the information that the question asked about and that therefore, by definition, is not known before such an answer is provided. More specifically, foci always corresponded to material that denoted information that was mentioned but not entailed by the preceding question. Under the hypothesis entertained here, comprehenders slow down on material that answers a preceding question because this is when they update their representation of the common ground with incoming, non-entailed information that—although previously mentioned in the question—was also left undecided by that question. I will therefore refer to this particular notion of predictability as *common ground entailment* here, to distinguish it from other notions of predictability related to givenness, surface structure, the general lexical frequency or surprisal of a particular word given its direct preceding context.

The hypothesis that focus slowdowns occur on material that is discourse non-entailed is perhaps reminiscent of the account of focus processing outlined by Benatar & Clifton (2014), who argue that focus slows down reading because focus constitutes new material. However, Benatar & Clifton (2014) define newness in terms of Schwarzschild's (1999) notion of givenness in which any phrase is new as long as it is not entailed by a salient discourse antecedent. The present data shows that this notion of givenness is not the right one to account for these focus slowdowns because foci in our cases did have salient dis-

course antecedents (i.e., their preceding questions) and still slowed down reading. Under Schwarzschild's definition, salient discourse antecedents do not themselves need to be entailed by the prior discourse. The motivation for this notion of givenness comes from examples like (10b), in which the fact that the phrase *apple* is deaccented is taken to indicate it to be given, though prior discourse does not itself entail that John ate an apple nor that there are any apples altogether (Schwarzschild, 1999: pp. 147-148).

- (10) a. If John ate a green apple, he will lose the contest.
b. Don't WORRY, he ate a RED apple.

Nevertheless, the phrase *green apple* may serve as a discourse antecedent for the subsequent use of *apple*. Discourse antecedents, under Schwarzschild's definition, are therefore pieces of linguistic structure which may provide antecedents for the givenness of other expressions, and there's no principled reason why the preceding questions in the GIVEN NF conditions of Experiment 1 could not have served a similar role. The hypothesis outlined here is thus subtly different from the one proposed by Benatar & Clifton (2014) because it does not make direct reference to newness of an expression itself but instead refers to which information is entailed by the common ground. A minimal requirement for this hypothesis to work out is the assumption that comprehenders track the entailments of the questions that are being raised in the preceding discourse, not just their form.

Note that an account of these slowdowns in terms of discourse entailment would still need to explain why targets that were part of a broad focused phrase did not give rise to a similar slowdown, because they were also non-entailed by the preceding context. One possibility for explaining this may lie in the fact that questions, by virtue of signalling which information is still unanswered, may perhaps also allow comprehenders to predict which

subsequent material is non-entailed. The assumption that comprehenders track what questions are being asked in discourse and what potential answers to these questions may look like, could perhaps account for the fact that listeners are able to predictively allocate more attention to such answers, thereby giving rise to slowdowns on narrow focused material, but not to material that was part of a broader focused phrase (see e.g., Cutler & Fodor, 1979 for an account of focus processing in terms of attention allocation). For the present, I set this possible interpretation of these results aside, and return to it in the next chapter (Chapter 4), where I will show that even this more general notion of attention allocation to discourse non-entailed material is insufficient to fully account for the observed slowdowns on foci, because such slowdowns were still observed on foci that did not provide answers to an explicit question and that were both discourse-given and entailed by their contexts.

In short, Experiment 1 was thus the first study to manipulate newness versus givenness and narrow versus broad focus independently of each other and to find an effect of focus within entirely given material. The difference between the broad versus narrow given conditions found here conceptually replicates Lowder and Gordon's observation that words take longer to read as they become more focused once sentence position is held constant, but at present with a different syntactic structure and task.

In the process, the narrow versus broad focus distinction was achieved by the inclusion or exclusion of contrastive alternatives in the context, e.g., *accountant*, to the ultimate target word, e.g., *lawyer*. A largely separate line of work has examined the role of focus in the subsequent processing of alternatives to those foci (see Chapter 5 for more details), but the role of contrastive alternatives in focus processing has been little explored in eye movement studies of the reading of focused words themselves. The next section presents a review of the previous reading studies on focus processing, in which the only studies that found

faster reading times on foci than non-foci were ones that presented alternatives to words that were focused by cleft constructions. This suggests that the role of alternatives in the processing of focus is one of those as-yet unaccounted for factors referred to by Lowder and Gordon and Benatar and Clifton that will be crucial for the construction of a complete understanding of focus processing. In fact, I will argue that these observed speed-ups can in part be accounted for via the explicit mention of contrastive alternatives in the context that can facilitate (or at least diminish the cost of) the processing of subsequent foci that are bound by a focus particle or cleft construction.

3.3 Contrastive alternatives in the processing of focus

In the standard theory of focus, foci are understood as introducing *contrastive alternatives*, a set of expressions that contrast with the focused element (Rooth, 1985) (see Chapter 2 for more background on theories that define focus in terms of contrastive alternatives). For example, in a sentence like (11), the alternatives to *cake* include, among other things, *steak* and *cookies*, since both expressions could be substituted for it to form a grammatical sentence.

(11) It was **cake** that Sarah wanted for dessert.

As discussed in Chapter 2, contrastive alternatives are well-known to play a key role in the inferences that clefts and focus particles like *only* give rise to. For instance, in (11), the comprehender is likely to understand that Sarah did *not* want any alternatives to cake such as cookies, ice cream or pie for dessert. Whether this particular inference is derived depends on whether *cookies* is considered a relevant contrastive alternative in this particular

context, which in turn depends on world knowledge, the content of the sentence itself, and the information provided by the preceding discourse context.

Notably, question/answer pairs give rise to a similar inference. In (12), the answer implies that Sarah did not want anything else besides cake for dessert, including possibly cookies.

- (12) a. What did Sarah want for dessert?
b. Sarah wanted cake for dessert.

Perhaps importantly for our understanding of the processing of focus, this inference in simple question/answer pairs is defeasible, with comprehenders less likely to draw it in every context (Hintikka, 1976; Groenendijk & Stokhof, 1984; van Rooy, 2003). This is unlike the alternative-dependent inferences involved in particles and clefts that are non-defeasible. Thus, in order to compute the final interpretation of the sentences containing such *bound foci* — foci which are signalled by a syntactic device in the same sentence — comprehenders are required to reason about contrastive alternatives.

Non-reading psycholinguistic studies have employed priming, lexical decision, and memory tasks to show that, when a focused expression is encountered, linguistic expressions that contrast with that focus (such as *cookies* for the sentence in (11)) become more strongly activated compared to expressions that are semantically associated with the focus but do not contrast with it (such as *pastry chef* when *cake* is focused; e.g., Braun & Tagliapietra, 2010; Fraundorf et al. 2010, 2013; Gotzner et al. 2016b; i.a.). These studies strongly suggest that integrating the meaning of foci requires comprehenders to not only represent what that sentence described, but also to calculate alternatives to what was asserted. These non-reading experimental results accord well with the theoretical semantic literature in lin-

guistics. In the standard theory, foci are the word(s) in a sentence that must be contrasted with alternative expressions in order to understand what the sentence means (Rooth, 1985, 1992a).

A survey of earlier reading studies in terms of the alternatives to foci that were present or absent in stimuli reveals that this dimension of focus perfectly demarcates studies by their reading time patterns. All of the studies which report decreased reading times on focused material are ones in which potential alternatives to words bound by a focus particle or cleft were presented before those foci. This was true of Birch and Rayner (2010), whose stimuli are repeated in (13).

(13) Context: The tenants at the complex were sick and tired of all the noise coming from #204.

- a. It was the **landlady** who confronted the woman who lived there. focus
- b. The **landlady** confronted the woman who lived there. non-focus

What (13a) conveys is that it was the landlady and not one of the tenants who confronted the woman who lived in the noise-making apartment. The word *tenants* can thus serve as an alternative expression to the focused *landlady* and was presented in the preceding context sentence; this was systematic throughout Birch and Rayner's (2010) items. This property also held of Morris and Folk's (1998) stimuli, the example of which is repeated in (14).

- (14)
- a. While the waiter watched, it was the **accountant** who balanced the ledger a second time. focus
 - b. It was the waiter who watched while the **accountant** balanced the ledger a second time. defocus

As with Birch and Rayner's (2010) stimuli, those in (14) mentioned an alternative person who was present, i.e., a *waiter*, who in the focus condition did not perform the action that the focused participant *accountant* performed. If the activation of alternative expressions to the one in focus is an integral part of language processing so as to understand the full import of what was conveyed by a message, then the presentation of these alternatives in Birch and Rayner's (2010) and Morris and Folk's (1998) stimuli may have facilitated the ultimate reading of the focused expressions in their studies.

In contrast, the studies which report reading time slowdowns on focus in eye movements did not present alternatives to the focused material in preceding context sentences. This was true of Birch and Rayner's (1997) first experiment, which did not employ preceding context sentences altogether. This property was also true of Lowder and Gordon's (2015) stimuli, even though these provided general contextual support for the target word. The absence of alternatives to target foci in the context also held for previous studies employing question/answer pairs as focusing devices (Birch and Rayner, 1997, experiments 2 and 3).

Even in Benatar and Clifton's (2014) studies, where stimuli were presented with preceding discourse context, the target words were difficult or impossible to understand as having contrastive alternatives. An example item from their first study is repeated in (15).

- (15) a. A: I'm confused, does Kyle care about Natalie?
B: Kyle cares about **Natalie**, but he doesn't show it. given
- b. A: Natalie is confused, does Kyle care about someone?
B: Kyle cares about **Natalie**, but he doesn't show it. new, rep
- c. A: Isabella is confused, does Kyle care about someone?

B: Kyle cares about **Natalie**, but he doesn't show it.

new, no rep

For a comprehender of (15) to establish that *Isabella* in (12c) was a contrastive alternative to a person named *Natalie*, either more contextual support or additional world knowledge would have been necessary, because proper names do not convey descriptive context. This is an easy intuition to grasp when it is compared with the results from semantic priming for contrastive alternatives to foci (e.g., Braun & Tagliapietra 2010; Fraundorf et al. 2010, 2013; i.a.): the name *Natalie* would not be expected to generally prime the name *Isabella* (it would only do so for people who know a person named Natalie and a person named Isabella from the same context). In their second study, Benatar and Clifton used hypernyms for target words, which contrasted with hyponyms in the preceding context. These expressions would not qualify alternatives, because alternatives must be exclusive of each other (consider the infelicity of *#I own a poodle, but not a dog*, unless the speaker were somehow claiming that a poodle is not a dog). Thus, Benatar and Clifton's studies, too, fit the pattern across all investigations of eye movements in the reading of focus: faster reading times on bound foci which were presented after contrastive alternatives, but slower reading times on foci in the absence of (unambiguous) contrastive alternatives.

The results of the entire literature are summarized in Table 3.4. It is only the difference between the presence versus absence of alternatives to foci that demarcates the faster from the slower reading of foci across this earlier literature. I take this as suggestive evidence that the alternatives-based understanding of focus that is employed in the theoretical linguistic literature may be useful for building theories of language processing as well.

Upon inspection of Table 3.4, several other patterns are apparent. All reading studies of focus before the present Experiment 1 had tested only new foci. All reading studies

	Inhibition	Facilitation	Construction	Alternatives	Newness	
					Focus	Baseline
Birch and Rayner (2010)	×	✓	clefts	present	new	new
Morris and Folk (1998)	×	✓	clefts	present	new	new
Ward and Sturt (2007)	×	×	wh-phrase	absent	new	new
Birch and Rayner (1997), Exp. 1	✓	×	clefts	absent	new	new
Lowder and Gordon (2015)	✓	×	(pseudo)clefts	absent	new	new
Birch and Rayner (1997), Exp. 2	✓	×	q/a pairs	absent	new	given
Benatar and Clifton (2014), Exp. 1, 2	✓	×	q/a pairs	absent	new	given
Benatar and Clifton (2014), Exp. 3	✓	×	indefinites	absent	new	given

Table 3.4: Overview of previous investigations of focus in reading.¹

that had employed question/answer pairs as focusing mechanisms did not present alternatives to foci. None of these studies investigated the reading of foci that were marked by focus-sensitive particles, such as *only*, which obligatorily focus an element in their scope. And, while the closest comparisons in the literature so far were between studies that employed clefts or (pseudo)clefts with or without the presence of possible alternatives to the foci, there still is not a minimal comparison of clefts that are always preceded by contexts, which themselves differ only in whether alternatives are present versus absent. This is because Birch and Rayner’s two cleft studies differed in the presence versus absence of entire contexts and Lowder and Gordon’s pseudoclefts differed from Morris and Folk’s clefts in sentential positions as well as not having contexts.

As other authors have noted, each focusing device carries with it certain unique demands, and Table 3.4 shows that the speed-up in reading times on focused material after the presentation of contrastive alternatives has only been demonstrated with clefted foci. It is possible that this pattern would hold only of clefts, or would only hold of structures that shared some property with clefts; this would account for why it was not observed in the present Experiment 1.

Support for this possibility, that the effect of contrastive alternatives interacts with the differences among focus constructions, comes from the theoretical semantics literature (Jackendoff, 1972; Rooth, 1985), which distinguishes between *free foci* and *bound foci* (also called “associated” foci, a term I avoid here and in subsequent chapters to forestall confusion with semantic association). Bound foci are those that are signaled by a particular syntactic construction, such as (pseudo)clefts or focus particles (e.g., *only*, *even*), while free foci are those that are merely mandated by context, such as by a preceding question, not by any expression in their immediate sentence. Clefts and focus particles generally require comprehenders to calculate construction-specific inferences or presuppositions, some of which are only optional for free foci. Moreover, bound foci are also more predictable in incremental processing, because many of the devices that bind them must precede them in the linguistic signal. The locations of the foci of clefts are predictable with a high degree of certainty before those foci have themselves been fixated, because it is always a word after *was* (or *is*) that is focused. Similarly, a focus bound by *only* always follows this particle, although this can be at a small distance. In contrast, a comprehender can only in some cases predict the positions of free foci, because it is sometimes only after some linguistic material has elapsed that this material could have sufficiently narrowed the possible continuations that would be congruent with the preceding focusing structure.

Explicit focusing devices like particles and clefts do not only cue the location of an upcoming focus, but they also overtly signal that alternatives to that focus need to be incorporated into the sentence meaning. It is thus the case that different focusing constructions could have different processing profiles in the presence or absence of earlier contrastive alternatives because of differences in how readily a reader can anticipate alternative-based computations. In line with Lowder and Gordon’s proposal of deeper encoding and greater

integration of focused material, it may be that readers are better able to allocate their resources toward an upcoming focus and its alternative set ahead of time when reading a bound focus than a free focus. Combining such an account with an alternatives-based understanding of focus, it may be that contextually mentioned contrastive alternatives can more greatly facilitate the processing of bound than free foci. Since incorporating the meaning of foci involves reasoning about alternatives, the presence of contrastive alternatives in the context, as well as the presence of a focusing device that cues how these alternatives should be incorporated, may allow comprehenders to initiate some of this reasoning process earlier on, i.e., upon encountering the focusing device, thereby facilitating comprehension of the subsequent focus itself.

This distinction between free and bound focus is also reflected in results from priming studies, which suggest that contrastive alternatives only become differentially pre-activated due to the presence of focus particles like *only* or *also*, but not due to the presence of question/answer focus (Braun et al., 2018). Converging evidence for the idea that comprehenders already start reasoning about contrastive alternatives when they first encounter a focus-sensitive particle also comes from visual world studies in which comprehenders' looks start converging to a depiction of a focused target upon encountering a focus particle before that focus (Kim et al., 2015).

It is in bound focus constructions that readers can take advantage of the pre-activation of contrastive alternatives to the foci they will need to comprehend. In the case of free foci, however, comprehenders must identify that material has been focused by preceding context anew in each situation; there are not such clear and consistent cues as dedicated lexical items like *only* or *it was a...* to signal focus and the relevance of the alternative set.

Indeed, recall that the presence of contrastive alternatives to target focused words in

preceding context sentences in Experiment 1 yielded longer reading times on foci than on non-foci. The alternatives in the narrow focus conditions of Experiment 1 did not cause those conditions to be read more quickly than the broad focus conditions, suggesting that it is not *only* the presence of alternatives or greater contextual support that caused Birch and Rayner (2010) and Morris and Folk to find faster reading times on foci than non-foci or defoci. I therefore argue that the role contrastive alternatives play in the processing of focus may depend on the type of focus, i.e., the use of question/answer pairs versus foci bound by focus particles or clefts. Experiment 2 and Experiment 3 therefore address both the question of whether the presence of preceding contrastive alternatives before focused words leads to faster response times with such bound foci and the question of whether there are differences between the processing profiles of different focus constructions.

In light of this similarity between focus particles and clefts, both these constructions were tested, respectively, in the presence or absence of alternatives in Experiment 2 and Experiment 3, which were designed to reveal the interaction of contrastive alternatives with bound focus constructions. The results of these studies suggest that for both clefts and particles like *only*, explicit mention of a contrastive alternative facilitates processing of the subsequent focus: Maze response times on foci were found to be shorter in the presence of contrastive alternatives than in their absence. This finding therefore also suggests a crucial difference between free and bound focus along the lines suggested above, where explicitly mentioned contrastive alternatives facilitate the processing of bound foci, but this facilitatory effect does not entirely override any slowdowns obtained on free foci.

3.4 Experiment 2

The only difference between Experiment 1 and Experiment 2 is that in the latter, the focus particle *only* was added to the target sentences. This particle unambiguously bound the target word and served two purposes. First, it provided a cross-experiment comparison between free and bound focus. Because the stimuli of Experiment 1 and Experiment 2 employed different focusing constructions, they differed in how clearly the position of their foci were signaled by these constructions. Second, the focus particle put the target word into narrow focus in all of the conditions of Experiment 2. It therefore allowed assessment of the effect of providing alternatives to target words in preceding contexts when focus status is held constant by a bound focus construction.

3.4.1 Method

Participants 58 native speakers of English were recruited via Prolific. All participants were compensated at a \$12 hourly rate. Completion of the experiment usually took 50 minutes including the practice phase. Data from 48 participants were included in the analysis; 10 participants were excluded because they failed to complete more than 70% of the Maze sentences.

Materials The stimuli of Experiment 2 were the same as in Experiment 1, except for the presence of the particle *only* immediately before the target word in each target sentence. An example of an item is shown in (16) below.

(16) **Speaker A:** This company often makes bad decisions, but...

- a. Did they hire a lawyer last fall, or an accountant? (NF) ALT, GIVEN

- b. Did they hire a lawyer last fall? (NF) NO ALT, GIVEN
- c. Did they hire an accountant last fall? (NF) ALT, NEW
- d. What did they announce last time? (NF) NO ALT, NEW

Speaker B: I think they announced they hired **only** a lawyer last fall,
but I'm not sure.

As in Experiment 1, a newness manipulation determined whether the target word was new or given by the time participants read it. Unlike Experiment 1, the target word of every condition in Experiment 2 was narrow focused. In (16), *lawyer* is bound by *only*, which puts it in narrow focus. This position of *only* immediately before the target word prevented it from being interpreted as binding any other word or phrase in the sentence. In order to facilitate comparison of these conditions with the ones from Experiment 1, the label “NF” is shown next to all the conditions of Experiment 2 in (16).

In order to interpret the meaning of *only* in a target sentence, comprehenders require contextually relevant alternatives to the target word, because the meaning of *only* is that nothing other than its bound focus is true in that context. As noted above, the preceding context questions used in both Experiment 1 and Experiment 2 manipulated the presence versus absence of an alternative to the target word. In Experiment 2, where all target words are focused by binding with *only*, this manipulation thus assessed the effect of explicitly provided alternatives in processing a focus that strongly supported an inference about alternatives, unlike the weaker inferences of the question/answer pairs in Experiment 1. Since an alternative question like that in (16a) presupposes that the mentioned alternatives are the only possible hires, *accountant* formed a salient alternative to the target *lawyer*. Similarly, the polar question in (16c) explicitly mentioned an alternative to the target word, *accoun-*

tant, but did not mention the target word itself. Thus, (16a) and (16c) are labeled “ALT,” while (16b) and (16d) are labeled “NO ALT.” All materials of Experiment 2 were assessed in an acceptability judgment study, the results of which can be found in Appendix I.

Procedure As in Experiment 1 and Experiment 5, the target sentences in Experiment 2 were implemented in the Maze task, in which response times were measured as the time it took for participants to choose between the actual continuation word and a foil.

Since the materials for Experiment 1 and Experiment 2 were the same except for the word *only* in the target sentence, the foils generated for Experiment 1 were used to create the foils for Experiment 2. To do so, the target sentences of Experiment 2 were used as the input to the AutoMaze algorithm to generate the appropriate foils for the word *only* in each item. Then, these foils for *only* were inserted into the foils that were already generated for Experiment 1. In this way, the differences between Experiment 1 and Experiment 2 were kept as minimal as possible, to provide maximal comparability between the two experiments. Fillers, practice items, comprehension questions, and presentation lists were the same as in Experiment 1.

Analysis Data were analyzed using R, version 3.6.3 (R Core Team, 2021). Bayesian (generalized) linear mixed-effect models were fit using Stan, as implemented in the brms package, version 2.18.0 (Bürkner, 2017), with the default priors. Separate models were fit to log-transformed response times and untransformed response times as dependent measures. For each model, we ran four chains, each with 5000 steps (warmup = 1000 steps). Rhat statistics in all models approached 1.00 and no warnings emerged. Models included fixed effects of newness and the presence versus absence of alternatives (contrast-coded), with the presence of an alternative to the a given focused target word as the reference level of

Condition	Previous -1	Previous	Critical region	Spillover	Spillover +1
(NF) ALT, GIVEN	776.95 (17.49)	676.20 (10.40)	799.06 (11.58)	758.62 (10.83)	735.89 (17.40)
(NF) NO ALT, GIVEN	793.35 (16.33)	683.25 (9.66)	791.93 (14.13)	782.73 (13.58)	747.24 (13.06)
(NF) ALT, NEW	811.27 (16.95)	711.83 (12.45)	901.01 (13.32)	793.31 (12.19)	713.45 (11.16)
(NF) NO ALT, NEW	909.15 (17.25)	772.62 (16.40)	968.70 (17.32)	876.82 (15.27)	835.61 (18.91)

Table 3.5: Experiment 2: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

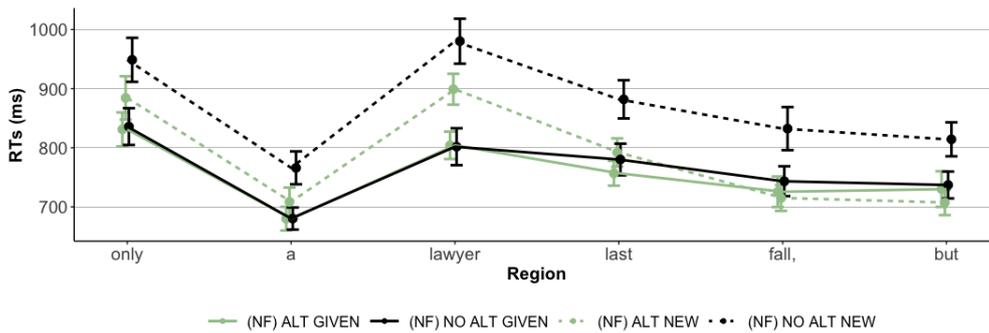


Figure 3.2: Experiment 2: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

this factor, and random slopes and intercepts for both subjects and items (Baayen et al., 2008).

3.4.2 Results

Mean response times for the target word and its surrounding regions in all conditions are given in Table 3.5. They are plotted with 95% confidence intervals in Figure 3.2. The mean comprehension question accuracy was 88%, and the mean completion rate of the maze target sentences of Experiment 2 was 87%. Posterior estimates for the model fit to log-transformed responses are reported in Table 3.6; those for the model fit to untransformed responses are reported in Table 3.7.

As in Experiment 1, the positive estimates for newness were reliable and indicated

		Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
ROI	(Intrcpt)	2.91	0.01	[2.89, 2.94]	1.01	620	1536
	Altern.	0.01	0.01	[-0.01, 0.02]	1.00	3772	3182
	Newness	0.07	0.01	[0.05, 0.08]	1.00	4132	3481
	New:Alt	0.04	0.01	[0.02, 0.06]	1.00	4893	3074
ROI+1	(Intrcpt)	2.88	0.01	[2.86, 2.90]	1.00	670	1047
	Altern.	0.02	0.01	[0.01, 0.03]	1.00	5651	3157
	Newness	0.03	0.01	[0.02, 0.05]	1.00	2945	2699
	New:Alt	0.03	0.01	[0.01, 0.05]	1.00	4435	3378

Table 3.6: Estimates for population-level effects in Bayesian mixed effects model of LogRTs in Experiment 2

		Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
ROI	(Intrcpt)	868.24	24.26	[820.76, 916.14]	1.00	1345	1860
	Altern.	39.90	19.55	[1.22, 78.49]	1.00	3401	3209
	Newness	137.91	19.14	[100.96, 175.01]	1.00	4581	3123
	New:Alt	86.12	32.06	[22.37, 150.59]	1.00	5103	3367
ROI+1	(Intrcpt)	800.66	25.22	[750.80, 850.01]	1.01	758	1245
	Altern.	55.79	13.09	[29.86, 81.01]	1.00	3079	2850
	Newness	67.72	16.63	[34.45, 100.16]	1.00	2294	2704
	New:Alt	61.86	29.20	[5.77, 119.94]	1.00	3252	3169

Table 3.7: Estimates for population-level effects in Bayesian mixed effects model of untransformed RTs in Experiment 2

that new targets were responded to more slowly than targets that were mentioned in the preceding question. The effect of the presence of alternatives was reliable in the model run on untransformed response times but was not reliable in the model run on log-transformed response times. The estimate for the interaction between newness and the presence of alternatives was also reliable, indicating that the difference in response times between the two new conditions was larger than the difference between the two given conditions. Pairwise comparisons on log-transformed response times confirm that 95% credible interval for the effect of presence of alternatives overlapped with zero in the given conditions ($\beta = 0.011, 95\%Cr.I. = [-0.007, 0.030]$), while the effect of alternatives between the new conditions did not ($\beta = 0.030, 95\%Cr.I. = [0.050, 0.010]$). Responses were thus reliably

slower in conditions without an alternative compared to those with an alternative but only when the target was also new.

On the word following the target word, models revealed a main effect of newness and a reliable interaction between newness and the presence of alternatives. Pairwise comparisons revealed that the effect of alternatives was reliable in the new conditions ($\beta = -0.038, 95\%Cr.I. = [-0.055, -0.021]$), but not in the given conditions ($\beta = -0.010, 95\%Cr.I. = [-0.024, 0.010]$).

3.4.3 Discussion

Experiment 2 replicated the effect of newness found in Experiment 1: responses were slower when a target word was new compared to when it was given. This finding also conceptually replicated the results of Benatar and Clifton's eye movement studies in which new information focus was found to cause significant slowdowns.

Experiment 2 also found limited evidence that preceding contextual information modulates the reading of foci. Narrow foci that were preceded by a contextually-mentioned alternative expression to the target word were read faster than narrow foci that were not preceded by an alternative, but only when the target itself was new. This may be because previously encountering the exact expression in focus or previously encountering an alternative to the focus can both aid in comprehending the focus itself. If these are the reasons why there was no difference between the two given conditions in Experiment 2, then this would point to an important difference between free and bound focus, because it would suggest that the presence of alternatives in the preceding context only aided comprehension of bound foci (as in Experiment 2), not free foci (Experiment 1).

However, it was also true that, across the two new conditions, the alternative-mentioned

condition contained more repetition of words before the target word than the no-alternative-mentioned condition. This could have facilitated processing of the alternative-mentioned condition throughout the sentence, as suggested by the generally lower reading times before and after the target word in this condition relative to the new one without an alternative. Without a difference between the given conditions, it is impossible to adjudicate between a contrastive alternatives-based versus simple repetition-based explanation for the faster response times to new alternative-mentioned conditions here in this study alone. However, the results of Experiment 3 for another kind of bound focus, clefts, suggest that the lack of difference between the given conditions in Experiment 2 is, itself, a floor effect, because the cleft structure reverses this difference in word repetition across conditions.

3.5 Experiment 3

The difference between Experiment 2 and Experiment 3 is that in the latter, an *it*-cleft was used to focus target words, instead of the focus particle *only*.

3.5.1 Method

Participants 53 native speakers of English were recruited via Prolific. Data from 48 participants were included in the analysis; 5 participants were excluded because they failed to complete more than 70% of the Maze sentences.

Materials The items of Experiment 3 consisted of modified versions of those of Experiment 2. An example of an item is in (17), below.

(17) **Speaker A:** This company often makes bad decisions, but...

- a. Did they hire a lawyer last fall, or an accountant? (NF) ALT, GIVEN
- b. Did they hire a lawyer last fall? (NF) NO ALT, GIVEN
- c. Did they hire an accountant last fall? (NF) ALT, NEW
- d. What did they announce last time? (NF) NO ALT, NEW

Speaker B: I think they announced it was a lawyer that they hired,
but I'm not sure.

As in Experiment 2, the preceding context questions of Experiment 3 manipulated whether an alternative to the expression in focus was either mentioned or not (ALT vs. NO ALT) and whether the focus itself was previously mentioned or not (GIVEN vs. NEW). Like the focus particle *only*, the cleft structure (*it was a...*) caused target words in all conditions of Experiment 3 to be unambiguously narrow bound foci.

Besides replacing *only* with a cleft, another difference in the target sentences between Experiment 3 and Experiment 2 was that the verbs of which the target words were direct objects were moved to immediately after target words, as in *lawyer that they hired* in (17). For this reason, Experiment 3 no longer confounded givenness with the simple repetition of the words immediately before the target word; if anything, it was the new condition without alternatives mentioned in (17d) that contained the most repetition across context and target sentences before the target word. This reversed the pattern of which conditions contained the most repetition from the one in Experiment 2. The final difference between the materials for these two experiments was that the phrase that previously functioned as a short spillover region (*last fall* in Experiment 1 and Experiment 2) was removed from the target sentence in Experiment 3 to make the target sentence slightly shorter and more natural.

All materials of Experiment 3 were first assessed in an acceptability judgment study;

Condition	Previous -1	Previous	Critical region	Spillover	Spillover +1
(NF) ALT, GIVEN	691.65 (10.52)	681.21 (9.19)	823.68 (9.19)	680.58 (8.42)	670.26 (11.46)
(NF) NO ALT, GIVEN	697.15 (10.78)	693.09 (9.84)	877.81 (16.87)	683.79 (9.84)	678.52 (11.91)
(NF) ALT, NEW	701.00 (11.80)	707.76 (10.44)	977.80 (16.66)	698.56 (9.43)	673.30 (10.68)
(NF) NO ALT, NEW	710.78 (11.44)	724.57 (10.59)	1160.42 (22.56)	736.85 (9.96)	736.54 (12.81)

Table 3.8: Experiment 3: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

the results of this can be found in Appendix I. Fillers, practice items, and comprehension questions were the same as in the previous two experiments.

Procedure As in Experiment 1 and Experiment 2, target sentences were implemented in the Maze task. Maze foils for Experiment 3 were independently generated using the AutoMaze algorithm, with the result that the foils in this experiment were not directly based on those generated for Experiment 1 and Experiment 2. This was necessary, because the target sentences in Experiment 3 are of a different structure from the target sentences in Experiment 1 and Experiment 2. For this same reason, a direct comparison between response times obtained in these experiments and those from Experiment 3 would not have been possible regardless of the way in which the foils were generated.

Analysis The analysis was the same as that of Experiment 2.

3.5.2 Results

Mean response times for the target word and its surrounding regions in all conditions are presented in Table 3.11. They are plotted with 95% confidence intervals in Figure 3.3.

The mean comprehension question accuracy was 86%, and the mean completion rate of the maze target sentences of Experiment 3 was 83%.

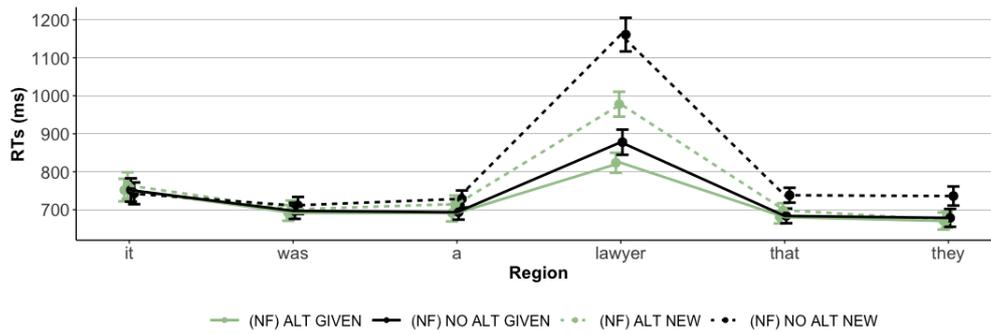


Figure 3.3: Experiment 3: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

Fixed effects estimates for the model fit to log-transformed response times are reported in Table 3.9; those for the model fit to untransformed response times are reported in Table 3.10. Positive estimates for newness again indicated a reliable slowdown on new targets compared to targets that were mentioned in the previous question. Unlike Experiment 2, the models fit to both log-transformed and untransformed response times of Experiment 3 revealed a small but reliable effect of the presence of alternatives, indicating that foci were read faster in the presence of an alternative in the context than in the absence of one. Finally, a reliable interaction between newness and the presence of alternatives was also found, suggesting that the difference in response times between the two new conditions was larger than the difference between the two given conditions. As in Experiment 2, pairwise comparisons on untransformed response times revealed that the 95% credible interval for the presence of alternatives did not overlap with zero in both the new conditions ($\beta = 182.61, 95\%Cr.I. = [131.49, 234.03]$), and the given conditions ($\beta = 55.24, 95\%Cr.I. = [11.97, 98.65]$), although models run on log-transformed RTs revealed that only the estimate for the presence of alternatives in the new conditions did not overlap with zero ($\beta = 0.07, 95\%Cr.I. = [0.05, 0.09]$). Models run on any of the regions following or preceding the critical region revealed no reliable effects.

	Estimate	Est.Error	1-95% CI	u-95% CI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	2.95	0.01	2.92	2.98	1.02	490	928
Alternative	0.04	0.01	0.03	0.06	1.00	2542	2755
Newness	0.10	0.01	0.09	0.11	1.00	2173	2866
Focus:Alternative	0.05	0.02	0.01	0.08	1.00	2960	2853

Table 3.9: Estimates for population-level effects in Bayesian mixed effects model of Lo-gRTs in Experiment 3.

	Estimate	Est.Error	1-95% CI	u-95% CI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	964.22	34.38	897.31	1032.48	1.01	608	1108
Alternative	118.93	19.78	80.55	157.06	1.00	2088	3145
Newness	221.62	18.68	186.43	258.13	1.00	2598	2589
Focus:Alternative	127.37	42.11	46.85	208.82	1.00	3420	3287

Table 3.10: Estimates for population-level effects in Bayesian mixed effects model of un-transformed RTs in Experiment 3.

3.5.3 Discussion

Experiment 3 replicated the newness effects reported above for both Experiment 1 and Experiment 2: In all experiments, responses were slower to new foci than given foci. Experiment 3 also replicated Experiment 2 in finding that the slowdown for new foci was smaller when a context mentioned an alternative expression to the target word. This effect from Experiment 2 was replicated in Experiment 3, even though it was the new conditions without alternatives that contained the most repetition across contexts and targets, that is, that would have been read the fastest if the difference between given conditions in Experiment 1 had been due to repetition. This suggests that, for bound foci generally, either previously encountering the expression in focus or previously encountering an alternative to the focus facilitates the comprehension of the focus itself. Together with Experiment 2, these results support the hypothesis that the presence of alternatives in the context aids the comprehension of a subsequent bound focus.

But neither Experiment 2 nor Experiment 3 identifies *how* explicitly mentioned alternatives have this attenuating effect in on-line focus processing. Contextually relevant

alternatives will most often be semantically associated with the foci with which they contrast. For example, in the example sentence in (11), repeated here in (18), both the expression *cookies* and *steak* may be contrastive alternatives to *cake*, some expressions may seem more natural or expected, and thus, more likely to be relevant alternatives than others.

(18) It was **cake** Sarah wanted for dessert.

If one were asked out of the blue to name “things like cake,” one would more likely name *cookies* and other desserts or baked goods before one named *steak*. These more expected alternatives (*cookies, brownies, pie*) contrast with a target expression (*cake*) on its more salient dimension(s), and are likely to be substitutable for that target expression in a larger set of contexts than a less-closely-related word that can still be an alternative in many contexts (*steak*).

However, semantic association alone is not enough to make an expression a viable contrastive alternative to a focus. Although an expression like *pastry chef* may be closely associated to the word *cake* and is possibly also relevant to the broader scenario described by (18), this expression cannot be an alternative to the focus *cake*, because we cannot substitute *pastry chef* for *cake* in this sentence. Further, in an out-of-the-blue context, *pastry chef* is not as expected an alternative for *cake* as many other expressions, because we would often not expect them to be contrasted with each other as options that would fulfill the same role in one situation. But an alternative expression such as *cookie* would likely be both highly relevant and replaceable with *cake*, and therefore would count as a relevant contrastive alternative, unless the comprehender of (18) also had access to some situational knowledge that ruled cookies out for other reasons (See Chapter 4 for more discussion on this possibility).

Could it thus be that the benefit for focus processing of contextually mentioning an alternative found in reported here is due to semantic associate priming of foci from their preceding alternatives? Understanding the real-time comprehension of focus requires understanding whether contrastive alternatives have any explanatory status in our theory of human language processing, or whether semantic associate priming can subsume the effects found in Experiment 2 and Experiment 3.²

Within the current studies, there is reason to hypothesize that contrastiveness cannot be reduced to semantic priming (convergent evidence for this from other studies will be discussed in Chapter 5). In Experiment 1, the same alternatives as those in Experiments 2 and 3 were used in preceding context questions to put target words in narrow focus. Instead of resulting in a significant speed up on this target region, the presence of these alternatives slowed down reading on this word. This finding already suggests that even if semantic priming drove the effects in Experiment 2 and 3, it did not affect reading times in the same way in Experiment 1. For this reason, in order to appeal to semantic priming to explain the effects of Experiments 2 and 3, one would also have to explain how the effect of semantic priming could be modulated by the type of focus construction (either free or bound focus) employed in these experiments. The predictability of bound foci may be a part of the explanation for why they are read less slowly in the presence of alternatives. But this greater predictability alone, absent any consideration of contrastive alternatives, does not account for the fact that the presence of alternatives seems to facilitate the comprehension of bound foci, because this predictability does not encompass the reason that alternatives are needed in the first place. It is the meaning of clefts and the particle *only* that requires the comprehender to consider contrastive alternatives, because those constructions require the

²We thank anonymous reviewers for emphasizing the importance of this point.

comprehender to draw inferences about what is *not* happening. This requirement would not be satisfied by semantic associates of a focused word that did not contrast with that word on a salient dimension or were not replaceable.

A clear prediction of this account is that the focus slowdown should be attenuated more by the presence of an alternative (whether this alternative is semantically associated to the focus or not), than a mere associate of a focused word. This motivated Experiment 4.

3.6 Experiment 4

To show that it is the presence of contrastive alternatives in a context, and not just semantic priming, that aids the comprehension of subsequent bound foci, the context sentences of Experiment 4 manipulated the presence of expressions that were semantically associated to upcoming foci independently of the presence of alternatives to those foci. If the facilitatory effect of alternatives found in Experiment 2 and Experiment 3 is solely due to semantic priming, then attenuation effects should parallel the degree of semantic association between contextually-mentioned words of any kind (whether alternatives or not) and foci. In the presence of alternatives that are not closely semantically related to the focus (*non-associated alternatives*), the benefit from alternatives should be weak or non-existent. Moreover, in such a scenario, semantically related words that nevertheless are unlikely to serve as contrastive alternatives to the focus (*associated non-alternatives*) would be expected to give rise to similar facilitatory effects as semantically associated alternatives. This must be understood as the likelihood of being an alternative, and not absolute possibility, because, for example, all imageable nouns could be alternatives in answer to the question *What did you see?*, but the intuition is still retained that the President of the United States and a pink armchair are unlikely to be alternatives to each other in many other scenarios.

Experiment 4 therefore investigates the extent to which both non-associated alternatives and associated non-alternatives aid the comprehension of a subsequent focus, by crossing contextual mention of alternatives with contextual mention of semantically associated expressions. If the benefit from the presence of contrastive alternatives in reading foci is not reducible to semantic associate priming, then alternatives that are not associated with foci would be expected to attenuate the focus slowdown more than associates that are not alternatives of those foci.

3.6.1 Method

Materials The items of Experiment 4 consisted of modified versions of those of Experiment 3. Preceding context questions manipulated whether a relatively likely alternative to the expression in focus was either mentioned or not (alt vs. no alt) and whether an associated expression to the focus was mentioned or not (assoc vs. non-assoc). An example of an item is in (19), below.

In the associated alternative condition, the context question contained an alternative (*painter*) that was strongly associated with the focus (*sculptor*), as in (19a). Here, *painter* and *sculptor* are related expressions, but both expressions contrast with each other along a single dimension. The associated non-alternative context question mentioned an associated expression that would not usually serve as a relevant alternative to the focus (*statue*), as in (19c). This is because in order to be a contrastive alternative to a focus, an expression needs to be replaceable with that focus, and there are fewer situations in which *statue* and *sculptor* are expected to be replaceable with each other than *painter* and *sculptor* (see *Alternatives in the processing of focus*, above). In this particular target sentence, *statue* ultimately cannot replace *painter*, because statues cannot give talks. For the purpose of incremental reading

in the Maze, where participants do not encounter the material that rules out *statue* until after the target word in the sentence, the manipulation depends on the fact that word *statue* is more generally unlikely be an alternative to *sculptor*, because the first is inanimate but the second is animate. The non-associated alternative condition mentioned an alternative that was only weakly associated (*lawyer*) with the focus, as in (19b). Even though this expression may not immediately come to mind when reading a word like *sculptor*, the word *lawyer* can still serve as a contrastive alternative because both are animate, and are therefore likely to both take similar roles in the events in which they participate and participate in similar events. Finally, the non-associated non-alternative condition mentioned neither a possible alternative nor a semantically associated expression, as in (19d).

(19) **Speaker A:** I can't really remember what talks are happening at the conference today.

- | | | |
|----|---|-------------------|
| a. | Will the last speaker be a <u>painter</u> ? | ALT ASSOC |
| b. | Will the last speaker be a <u>lawyer</u> ? | ALT NON-ASSOC |
| c. | What did you say about a statue? | NON-ALT ASSOC |
| d. | What did you see on the program? | NON-ALT NON-ASSOC |

Speaker B: I think I saw that it was a sculptor who will be giving the last talk of the day, but I'm not sure.

As in Experiment 3, a cleft was used to unambiguously put the target word (*sculptor*) in narrow focus in all conditions. In all conditions, the focused target expression itself was new.

The level of semantic association between the expressions in focus and their alter-

natives or associated non-alternatives was based on their Latent Semantic Analysis scores (Landauer, 1999). For each experimental item, semantic association between the focus and both the associated alternative and the associated non-alternative was at least .3, while the semantic association between the focus and the non-associated alternative was at most .13. Moreover, the difference in LSA score between the associated non-alternative and the associated alternative was larger than -0.1. Out of the 48 items that were written, 24 were based on quadruplets from Husband & Ferreira (2016), where only those items were selected that satisfied the criteria above. A list of the key words of all 48 items is given in Appendix III.

Practice items and comprehension questions were similar to the previous three studies. 64 additional filler sentences were included, 48 of which also involved either a cleft or a focus particle and 16 of which involved only broad focus.

Procedure Maze foils for Experiment 4 were generated using the AutoMaze algorithm. Again, context sentences were presented normally on a separate screen prior to the target sentence which was presented using the Maze task.

Participants 52 native speakers of English were recruited via Prolific. Data from 48 participants were included in the analysis; 4 participants were excluded because they failed to complete more than 68% of the Maze sentences.

Analysis The analysis was the same as that of Experiment 3, except that fixed effects were the presence versus absence of an associated expression and the presence versus absence of alternatives, again contrast-coded. The presence of an alternative/associated expression was treated as the reference level of these factors.

Condition	Previous -1	Previous	Critical region	Spillover	Spillover +1
(NF) ALT, ASSOC	708.90 (11.52)	713.56 (12.01)	1004.01 (19.76)	712.43 (19.35)	750.47 (25.72)
(NF) ALT, NON-ASSOC	695.02 (11.20)	718.57 (13.63)	1299.07 (27.80)	717.78 (21.94)	724.22 (22.91)
(NF) NO ALT, ASSOC	699.40 (10.56)	725.78 (12.31)	1151.17 (23.26)	752.25 (26.81)	837.98 (29.74)
(NF) NO ALT, NON-ASSOC	702.22 (12.03)	755.04 (13.67)	1378.40 (30.08)	755.86 (26.82)	850.51 (36.47)

Table 3.11: Experiment 4: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

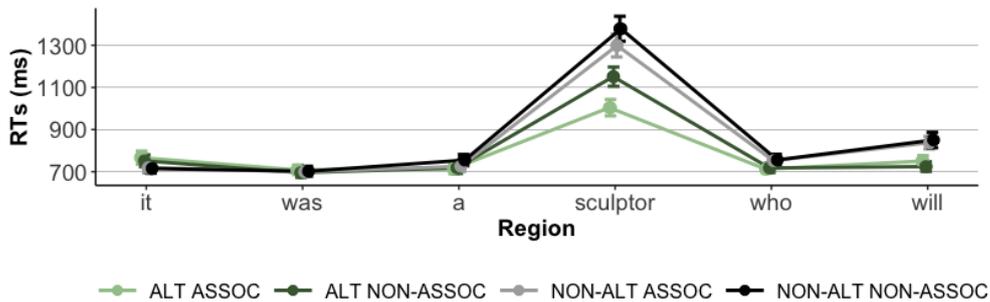


Figure 3.4: Experiment 4: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

3.6.2 Results

Mean response times for the target word and its surrounding regions in all conditions are presented in Table 3.11. They are plotted with 95% confidence intervals in Figure 3.3.

The mean comprehension question accuracy was 87%, and the mean completion rate of the maze target sentences of Experiment 4 was 85%.

Fixed effects estimates for the model fit to log-transformed response times are reported in Table 3.12; those for the model fit to untransformed response times are reported in Table 3.13. Like Experiment 3, the models fit to Experiment 4 revealed a reliable effect of the presence of alternatives, indicating that foci were read faster in the presence of an alternative in the context than in the absence of one. Moreover, models also revealed a reliable effect of association, indicating that foci were read faster in the presence of a semantically associated

word than in the absence of one. Pairwise comparisons on untransformed response times revealed that the effect of the presence of alternatives was reliable within both the associated conditions ($\beta = 258.82, 95\%Cr.I. = [194.82, 321.56]$) and the non-associated conditions ($\beta = 328.28, 95\%Cr.I. = [225.39, 430.14]$).

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	2.97	0.01	2.95	2.99	1.00	1973	2317
Association	0.06	0.01	0.04	0.08	1.00	3349	3011
Alternative	0.10	0.01	0.08	0.13	1.00	2619	2961
Assoc:Alt	-0.03	0.01	-0.06	-0.00	1.00	3094	3108

Table 3.12: Estimates for population-level effects in Bayesian mixed effects model of Lo-gRTs in Experiment 4.

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	1002.56	28.47	947.11	1058.52	1.00	3028	3089
Association	148.69	32.53	83.56	211.52	1.00	4354	2970
Alternative	293.55	46.13	202.35	383.30	1.00	2602	2669
Assoc:Alt	-69.45	49.25	-164.65	28.05	1.00	3198	2991

Table 3.13: Estimates for population-level effects in Bayesian mixed effects model of untransformed RTs in Experiment 4.

3.6.3 Discussion

Experiment 4 replicated the effect of the presence of alternatives found in Experiment 2 and Experiment 3. In the presence of alternatives in the context, responses were faster than in their absence. Although the presence of semantically associated expressions generally facilitated the reading of a subsequent focus, the presence of alternatives in the context reduced response times independently of semantic association: responses on targets were faster in the presence of alternatives even when these alternatives were not associated with the focus. Moreover, the facilitatory effect of alternatives in the context (whether associated or not) was stronger than the facilitatory effect of expressions that were semantically associated to the focus but could not serve as an alternative to the focus. This suggests that

the facilitatory effect of alternatives in Experiment 2 and Experiment 3, too, cannot solely be due to semantic priming.

3.7 Conclusion

Experiment 1 demonstrated that focus effects in reading are not reducible to the newness/givenness distinction, and Experiments 2-4 demonstrated that, instead, the appropriate understanding of focus for language processing research must reference which parts of a sentence are most relevantly contrasted with alternatives. The results of Experiment 1 supported this conclusion, because longer response times were found on narrow focused words than words that were part of broad focused phrases, even after controlling for newness versus givenness. This manipulation of the size of foci was achieved by presenting contrastive alternatives in context questions before target sentences which did not, themselves, contain an explicit focusing construction. At the same time, Experiments 2-3 demonstrated that the earlier mention of alternative expressions can somewhat attenuate the cost of processing new material when that new material is also a bound focus, i.e., when it is explicitly cued and gives rise to a undefeasible inferences. Experiment 4 showed that this effect of explicit mention of alternatives in the context cannot solely be due to the fact that those alternatives semantically prime focused targets.

Overall, these results accord with the findings of Benatar and Clifton (2014), Birch and Rayner (1997), and Lowder and Gordon (2015), who all argued for a general processing cost of focus based on observed longer reading times in both early and late eye movement measures (with significant slowdowns reported in e.g., first fixation, gaze duration, regression path duration and total reading times). But this general focus slowdown cannot be reduced to the newness/givenness distinction, even in the absence of extra infer-

ences or contextual support. Instead, the present findings are more in accord with Lowder and Gordon's interpretation of focus processing costs as deeper encoding or more effortful integration of focus. These results are thus also in line with the understanding of focus processing proposed in Chapter 2, in which the presence of focus marking generally incurs a processing cost, that is not due to the newness of material but instead to the comprehension of focus marking in its relation to a set of contextually relevant alternatives.

The present findings are also potentially compatible with the speed-ups on focused material reported by Birch and Rayner (2010) and Morris and Folk (1998), who report shorter reading times in first fixations, gaze durations, as well as total reading times. Both Birch and Rayner and Morris and Folk made use of materials in which target words were new, alternatives to the expression in focus were explicitly mentioned, and target words were focused by clefts, just as in the present Experiment 3 and Experiment 4. While Experiment 3 and 4 only found that new foci which followed alternatives were read *less slowly* than new foci which did not follow alternatives, without evidence of a speed-up, the present studies' baseline conditions were unlike Morris and Folk's and Birch and Rayner's. Looking more closely at Morris and Folk's materials may provide a clue for an alternative explanation about why such a speed-up may have arisen. An example item is repeated in (20) below, in which an alternative, *waiter*, always preceded the target word *accountant*.

- (20) a. While the waiter watched, it was the **accountant** who balanced the ledger a second time. focus
- b. It was the waiter who watched while the **accountant** balanced the ledger a second time. defocus

It may be that this earlier alternative expression, *waiter*, was ultimately also understood as

focused by the readers of both of these sentences, because it was understood in clear contrast with *accountant*. In other words, the target word *accountant* in the defocus condition might have received contrastive focus as well, because it seemed like a relevant alternative to *waiter*. In that case, the comparison made in this study would have been one between an ultimately contrastive focus without a preceding alternative as in (20b), because the waiter was ruled out of potentially balancing the ledger by the time the accountant was encountered, and a focus inside a cleft with a preceding alternative as in (20a), where the latter type of focus gave rise to shorter reading times than the first. This could have been due to the focused target word in (20a) being more clearly demarcated as focused by its preceding cleft than the ultimately contrastively focused target word in (20b) requiring more inference on the comprehender's part. If the speed-up in reading the focused target words in Morris and Folk's study was due in large part to a combination of the presentation of alternatives before the target word and the clarity of focus marking provided by cleft constructions, then this explanation would extend to Birch and Rayner's (2010) faster reading times on focused words as well.

If inherent ambiguity in the location and size of a *free* focus makes it more costly to process than a focus bound by a cleft or *only*, which are overtly signaled, then the different patterns of processing times on foci after alternatives in the present Experiment 1 versus Experiment 2 and 3 could be understood as the construction-specific demands of focus processing. Morris and Folk's and Birch and Rayner's studies may, in fact, be better understood as more similar to comparing the broad focused, no-alternatives-mentioned, new condition of Experiment 1 as a baseline against the narrow focused, alternatives-mentioned, new condition of Experiment 3. At this point, it is not clear whether the facilitated reading of bound foci after explicitly mentioned alternatives that we observe here is due to the par-

ticular properties of the syntactic expressions (clefts, *only*) they were linked to, or whether it is due to the general fact that they are bound at all (and hence, we do not know whether foci bound by other particles, such as *too* or *even*, would show the same effect).

One possible piece of evidence in support of the suggestion that free foci are generally more costly to process comes from self-paced reading studies reported by Fraundorf et al. (2013), who also showed slowdowns on foci that occurred even after the explicit mention of contrastive alternatives. Unlike any of the studies discussed here thusfar, in Fraundorf et al.'s materials, foci were marked using font emphasis. No focusing device, whether contextual or syntactic, signalled the presence of the upcoming focus in advance of the emphasized word. Fraundorf et al.'s studies may therefore have yielded a slowdown even following contextually-mentioned alternatives, because their conditions had in common with free foci the property that comprehenders were not able to confidently anticipate a focus before they encountered it.

The studies reported here thus provide support for Benatar and Clifton's and Lowder and Gordon's suggestion that different focus constructions may all be processed slightly differently. The attenuation of a newness slowdown when alternatives to foci were explicitly mentioned was only observed for material that was focused by either the particle *only* or a cleft, that is, for bound foci. In Experiment 1, the narrow foci necessarily occurred in a context in which an explicit alternative was mentioned, but these new narrow-focused target words were not read faster than target words that were part of a new broad-focused phrase. Alternative expressions seem to be most useful when the focus structure of a sentence is clearly signalled. This difference between bound and free foci is expected under the view for focus comprehension outlined in Chapter 2, because when contrastive alternatives are given in the context the alternative set of a focus can already be constructed, but this encoded

alternative set can only help in processing the focus itself if the presence of an upcoming focus, and therefore the relevance of the encoded alternative set, is also signalled ahead of time.

This chapter therefore puts forward evidence that previous reading results can be explained by adopting the appropriate (computational level) understanding of focus for psycholinguistic theories. This is the same as the understanding of focus in formal linguistics — the only property that unifies all focus constructions is the requirement that contrastive alternatives be considered in order to understand the meaning of focused expressions. Such an alternatives-based conceptualization of focus for language processing is compatible with results from eye movements, the Maze task, self-paced reading, semantic priming, and event-related potentials, which all converge on the conclusion that comprehenders automatically consider alternatives to focused expressions during the course of real time language processing. I thus propose that psycholinguistic theories adopt the concept of contrastive alternatives to explain the comprehension of focus.

At a more algorithmic level, alternative expressions may provide some semantic associate priming benefit to upcoming foci, and the process of fully comprehending a focus may encompass, first, the activation of semantically associated expressions, followed, second, by the narrowing of those associated expressions into only the set that would be contrastive in the current context, as has been suggested by Husband & Ferreira (2016), *inter alia*. But the results presented in this chapter also show that the presence of contrastive alternatives provide a benefit even when they do not prime the focus. This indicates that contrastive alternatives are more directly computed or retrieved via their contrastiveness, because comprehenders already have *a priori* expectations about the salient dimensions along which concepts are likely to be contrasted with each other when they first encounter

a focused word. Thus it may be either the less effortful computation or faster retrieval of an alternative set to a focus that underlies the facilitatory effect of contrastive alternatives observed here. Either of these mechanistic understandings of focus processing would accord well with both the studies that have found activation of alternative sets from focused words (Braun & Tagliapietra, 2010; Fraundorf et al., 2013, 2010; Gotzner et al., 2016b; Husband & Ferreira, 2016) and a growing body of reading studies that have demonstrated that comprehenders use the content of focused expressions to anticipate the upcoming mention of contrastive alternatives (Filik et al., 2009; Ferreira & Lowder, 2016; Lowder et al., 2021).

The findings reported in this chapter thus raise many questions about the specific mechanisms that underlie the facilitative effect of explicitly mentioned alternatives. One of these questions also involves what the properties are that make comprehenders consider an expression a viable contrastive alternative to a focus. In this chapter, it is already clear that mere semantic association between an expression and subsequent focus is not enough for an expression to be considered an alternative, because foci were read faster in the presence of unassociated alternatives than in the presence of mere semantic associates. I further address this question in Chapter 5, where I investigate what properties of the discourse context determine whether comprehenders include or exclude a certain mentioned expression in the alternative set to a focus.

Although the present results are thus not able to determine the exact mechanisms through which contrastive alternatives are involved in the processing of foci, these data do confirm the predictions of a more intermediate-level view on focus processing proposed in Chapter 2, in which the facilitative effect of explicit contrastive alternatives in the context may be due to either of the subprocesses of focus comprehension identified in that chapter. That is, the present data is in line with the hypothesis that the presence of contrastive

alternatives in the context facilitate the comprehension of focus because they allow comprehenders to either more easily ② construct the relevant alternative set, or ③ establish a dependency with the discourse context, or both.

Finally, if bound and free focus share an interpretive dependence on alternatives, contrastive alternatives may be involved even in the processing of free foci, for instance in the assignment of focus marking. In the next chapter, I will therefore further investigate the role of contrastive alternatives in the process by which focus marking is assigned to a sentence during incremental interpretation, i.e., subprocess ①. I will show that the presence of contrastive alternatives in the context guides the assignment of focus marking in sentences that are in principle compatible with multiple focus structures. In order to show that it is specifically a notion of contrastive alternatives that is relevant—and not other cues from context such as the presence of an overt question—I show that focus can be reliably assigned when contrastive alternatives are mentioned in the context even in the absence of such questions.

Chapter 4

Alternative sets guide the on-line assignment of focus structure

4.1 Introduction

Results from the preceding chapter showed that the processing of focus is modulated by several factors. Data from four reading studies showed, first, that reading of foci was modulated by givenness, though the presence of focus marking slowed down reading even when foci were given, suggesting that the processing of focus induces a cost that is not due to incorporating new material alone. These results also showed that the reading of focus depends on salient *contrastive alternatives*—expressions that contrasts with and can replace the expression in focus—because reading of foci was facilitated when the context presented such contrastive alternatives. I argued that this facilitatory effect of contrastive alternatives is due, at least in part, to the fact that such alternatives allow comprehenders to construct the relevant alternative set to a focus ahead of time. However, another possibility, which I investigate in this chapter, is that the presence of contrastive alternatives allow comprehenders to anticipate the location and content of upcoming foci themselves.

In most studies investigating the behavioral effects of focus, the location of focus was unambiguously signalled—via the presence of accents, focus particles or cleft constructions—but sentences are often ambiguous with respect to the size and location of the focus they contain. The way in which comprehenders assign a focus structure in such cases has received considerably less attention. The goal of this chapter is, first, to investigate how comprehenders decide which material is put in focus during silent reading based on context; and second to further probe why the observed focus slowdowns arise in the first place. These two questions are related, because answering the first question will shed light on the mental representations that are involved in the processing of focus, which in turn will allow us to better understand the nature of focus processing itself.

In three reading studies, I show that comprehenders generally encode what contrastive alternatives are relevant in a discourse context, and that such representations guide the assignment focus marking in subsequent sentences. Experiment 5 first shows that the assignment of focus must involve more than the anticipation of an (implicit) accent. In this experiment, effects of focus were observed on material that was put in focus by virtue of answering a preceding question but on which no accent would be predicted, suggesting that focus processing must involve abstract representations beyond the (implicit) prosody of a sentence. Experiment 6 then shows that even in the absence of an explicit question salient alternatives in the context can be used to determine what phrases are put in focus. This shows that the incremental assignment of focus is mediated, more generally, by comprehenders' representations of alternative sets. In fact, Experiment 7 shows that such alternatives play a role in the comprehension of discourse even when the need to consider alternative expressions is not explicitly signalled by a focus particle. Together, these experiments show that focus can be anticipatorily assigned to a sentence based on abstract representations that

are encoded and maintained over time.

This conclusion has consequences for the way the behavioral effects of focus in general must be conceptualized, because these findings also suggest these effects cannot only be due to the prioritization of accented, prominent, important or new information, but at least in some cases have to stem from comprehenders' structuring of information in discourse more generally. In Experiment 5, focus slowdowns were observed even on given foci that were not prosodically prominent. Experiment 6 and Experiment 7 compare the reading profile of new foci with foci like those in (1b)—also called second-occurrence (SO) foci, which have already been interpreted as foci in the preceding context, and therefore allow us to disentangle effects of predictability of upcoming material from effects of focus marking itself.

- (1) a. A: Sarah only read a book about [bats]_F.
b. B: No, LILY_F only read a book about [bats]_{SO}.

The data from these experiments shows that focus marking still causes slowdowns in these cases—i.e, in sentences where foci are fully recoverable from their discourse context and their corresponding alternatives and inferences do not need to be computed anew. Although the assignment of focus depends on what alternatives are salient in the context, once a focus structure has been assigned to a sentence the differential allocation of resources to those foci takes place even when they are fully predictable and do not provide novel answers to a preceding question.

In the remainder of this section, I will provide some background on the role of discourse in disambiguating the focus structure of a sentence, pointing to cases in which it is discourse context, and not prosody, that determines where the edges of a focus marked

phrase lie. This discussion will motivate the design of Experiment 5, which tests the reading profile of sentences whose prosody is compatible with multiple focus structures. Then, Section 4.3 will motivate the design of Experiment 6 and Experiment 7 by outlining further predictions and open questions of an alternative-based account of focus processing that these two experiments aim to test.

4.1.1 Assigning focus based on context

Psycholinguistic studies have repeatedly shown that the presence of focus prosody has important ramifications for the way language is processed. But these studies alone do not determine whether such effects are due to comprehenders in fact assigning a focus structure to the abstract representation of a sentence during listening, rather than to the prosodic signature of focus itself. Before investigating *how* focus is assigned to a sentence, it should first be shown that comprehenders indeed assign focus marking in the first place. What will be crucial in making this argument, and in motivating the design of Experiment 5, is the observation that even in sentences whose intonational signature is compatible with multiple focus structures, preceding context can disambiguate the location and size of a focus. Therefore, effects of focus can be disentangled from effects of focus prosody because the focus structure of a sentence can be manipulated via context while keeping the prosody of a sentence constant.

One way in which context determines focus structure is that in well-formed answers to wh-questions, the constituent corresponding to the wh-phrase has to be put in focus—a principle also referred to as *question-answer congruence*. In the question/answer pair in (2), *dinosaurs* substitutes for *what*, and therefore has to be focus marked in (2b), as signalled by the presence of sentence-level stress and a pitch accent on this phrase. When a pitch

accent is instead placed on a different constituent, as in (2c), the sentence is an incongruent response to the question.

- (2) a. A: What did Sarah read an article about?
b. B: Sarah read an article about [DINOSAURS]_F.
c. B: #[SARAH]_F read an article about dinosaurs.

In these cases, it could therefore be that comprehenders use information about the preceding question to assign focus to its answer. Indeed, there is ample evidence that the presence of a focal accent like the one on *dinosaurs* in (2b) has significant behavioral effects, but some evidence also suggests that, even in the absence of a prosodic signature that indicates focus marking, preceding context alone may yield similar effects.

For instance, Cutler & Fodor (1979) found faster responses in phoneme-monitoring tasks to words which answered a wh-question, even when prosodic cues indicating that this word was put in focus were absent (Akker & Cutler, 2003; Ip & Cutler, 2020). These results are informative, both regarding the way listeners assign focus to a sentence, as well as with respect to the source of the observed focus effects: These results suggest, first, that the presence of such questions enables listeners to rapidly assign focus to their answers, giving rise to the same behavioral effects as the presence of a pitch accent itself; and second, they indicate that effects of focus marking cannot solely be attributed to properties of the auditory signal of these accents themselves (such as a potential greater acoustic clarity of accented compared to unaccented words).

Effects of preceding questions have also been found in silent reading, during which readers have to reconstruct the prosody of the sentences they read based on discourse con-

text (Lowder & Gordon, 2015; Birch & Rayner, 1997). In Benatar & Clifton (2014), preceding questions were shown to cause slowdowns on answers to these questions. In Chapter 3 of this dissertation, too, longer response times were observed on material that answered a preceding question than on material that did not. Together, these reading results also suggest that the reading profile of sentences may be affected by preceding questions in the absence of auditory cues to the location of an accent.

However, although these findings are therefore consistent with the hypothesis that readers assign a focus structure based on such questions, it may still be that anticipation of an accent (implicit or otherwise) caused these effects. It may be, for instance, that the human perceptual system is particularly attuned to allocating attention to accents and that this generally affects the processing of language even when the bottom-up signal does not in fact contain such an accent. Faster responses in phoneme-monitoring may therefore still be the results of accenting in an indirect way, because even in studies that did not involve any auditory cues to an accent, a manipulation in focus placement may have yielded significant effects simply because focal accents themselves were anticipated. Such an explanation may even account for the reading results on focus, because it may be that the implicit prosodic structure that is assigned during silent reading could be used to differentially allocate resources (Breen & Clifton Jr, 2011; Breen, 2014)—resulting in longer reading times on material that is predicted to be implicitly accented as well (see e.g., Lowder & Gordon 2015 for an account that would be consistent with this hypothesis). It is therefore still an open question whether comprehenders even assign an underlying focus structure in addition to predicting upcoming accents. More generally, in order to show that focus marking as an abstract category can have effects beyond the way that it interacts with the prosody of a sentence, the behavioral signature of unaccented focused material also needs to be

investigated.

Fortunately, there are many test cases that would allow us to tease these two hypotheses apart because not all focused material also receives a pitch accent. For instance, in answers to *wh*-questions, the form of a preceding question affects not just the location of the focus in the answer, but also the size of the focused phrase. Regardless of the size of a focus, only one focal pitch accent is assigned to this material, in English typically to the last stressed syllable of a focused phrase. For instance, in (3), the whole phrase *an article about dinosaurs* is in focus because this is the answer to the question what Sarah read, while only the last word *dinosaurs* receives a focal pitch accent.

- (3) a. A: What did Sarah read?
b. B: Sarah read [an article about DINOSAURS]_F.

For foci that provide answers to preceding questions like these, the location within a sentence and their extent is, in principle, unrestricted. Depending on the question, larger and larger parts of the answer can be put in focus.

- (4) a. A: What did Sarah do?
b. B: Sarah [read an article about DINOSAURS]_F.

- (5) a. A: What happened?
b. B: [Sarah read an article about DINOSAURS]_F.

More generally for foci larger than one word in English, material at the left edge of a focus phrase remains unaccented despite it being put into focus. A sentence with a specific prosody can still be compatible with different underlying focus structures, even though the

presence of focus marking is typically signalled via prosodic prominence in English. Such wider foci thus allow us to disentangle effects of the anticipation of an accent from effects of the abstract representation of focus marking itself. Experiment 5 tests the reading profile of such wider foci, in which the left edge of the material in focus does not correspond to material to which an accent would be assigned if correctly anticipated, in order to show that it cannot be the assignment of (implicit) prosodic prominence that underlies all focus slowdowns in reading.

4.2 Experiment 5

To manipulate focus independently from the assignment of a pitch accent, Experiment 5 tested reading times on given foci of varying sizes. Like Experiment 1 reported in Chapter 3, the focus size was manipulated by the introduction of preceding context questions, keeping the form of the target sentence constant across conditions.

Following the methodology in Chapter 3 of this dissertation, focus marking was also manipulated in such a way that the focused phrases were always discourse-given, i.e., they constituted material that was always mentioned in the prior discourse. This was done to rule out an explanation of the obtained effects in terms of a cost for material that was newly mentioned in the discourse, as has been proposed by Benatar & Clifton (2014). Experiment 5 hence manipulated focus size independently of newness, and, to my knowledge, was the first study to compare non-accented focused material with non-focused baseline conditions while also keeping givenness of such material constant.

4.2.1 Method

Materials Each item of Experiment 5 consisted of a short dialogue between two speakers, in which Speaker A asks a question that is answered by Speaker B. The size of the focus marked phrase in Speaker B's answer was manipulated by the shape of Speaker A's question, so that the surface form of the answer was identical across conditions. I take the focus in the target sentence to be the phrase that provides the answer to the preceding question. In all conditions except the BROAD focus baseline condition, alternative questions (i.e., questions in which two alternatives are given in the form of a disjunction) were used in which the size of the disjuncts determined what the answer to that question was and thus what phrase was put in focus. This is illustrated for the example item in (6).

(6) **Speaker A:** I know Eli is a peculiar guy, but I forget...

- a. Does he sell books about penguins, or whales? NARROW NP (GIVEN)
- b. Does he sell books about penguins,
or magazines about whales? WIDE NP (GIVEN)
- c. Does he sell books about penguins,
or write magazines about whales? VP (GIVEN)
- d. Does he sell books about penguins? BROAD (GIVEN)

Speaker B: I think Eli said [he sells books about penguins] right now,

but I'm not sure

The target sentence consisted of multiple clauses where the embedded clause (*he sells books about penguins*) included the regions of interest and material in the main clause

and spillovers were included to ensure naturalness across conditions. The entire embedded clause was given in all conditions because this material was mentioned by all of the preceding questions. This was the case in the BROAD focus baseline target sentences because these conditions always included a polar question in the context whose answer constituted the entire clause. In the non-baseline conditions, the phrase that formed the answer to the question (and therefore the phrase put in focus by that question) was either only a single noun (in the NARROW NP focus condition), a larger noun phrase containing that noun (in the WIDE NP focus condition), or the entire verb phrase (in the VP focus condition).

Moreover, if pronounced out loud, the location of the focal accent would be the right edge of each of these focus marked phrases and was therefore identical across conditions. The left edge of the focus varied among conditions, however. Any slowdown at these left edges would thus indicate a slowdown that is due to the form of the question, and not the anticipation of a pitch accent during silent reading. These left edges thus constituted the regions of interest. If focus and not just accenting slows down reading we would expect slowdowns for (6) on *sells* in the VP focus condition relative to both the WIDE NP and NARROW NP conditions, and on *books* in both WIDE NP and VP focus conditions relative to the other NARROW NP conditions.

It is not immediately obvious what exact pattern of response times to expect for the BROAD focus condition, because there is some theoretical indeterminacy as to whether broad focus phrases involve the absence of focus marking or involve focus marking throughout the entire phrase. On the one hand, since this entire sentence provides the answer to the preceding question, this condition may yield slowdowns throughout. However, this condition may also constitute the absence of focus marking, and therefore yield shorter response times than any of the other conditions throughout all regions. Both of these scenarios would

be compatible with the hypothesis that readers slow down on foci and not just on accented material.

In total, 60 items like (6) were constructed. Using a latin-square design the experimental items were divided over 4 lists, interspersed with 48 filler items.

Procedure Target sentences were presented using the Maze task, while context sentences were presented normally. Foils were automatically generated using the AutoMaze software developed by Boyce, Futrell, and Levy (2020). An example of the AutoMaze output for one target sentence is given in (7) below. On the second line, the distractor word is presented below its corresponding word of the target sentence.

(7) I think Sarah said she recommended a documentary about dolphins, but
x-x-x apart Came fine call electricity ew enterprises trump repaired, jack
I might be misremembering it.
hill glass laws hypothyroidism am.

On every trial, participants first read a context sentence on one screen. On a subsequent screen, participants were presented with the start of the target sentence in the format of the Maze task. That is, only the utterance of Speaker B was presented incrementally; the utterance of Speaker A was presented all at once for normal reading. The context sentence disappeared from the screen when participants moved on to the target sentence.

To ensure careful reading of the context, all experimental trials were followed by a comprehension question that probed various properties of the context preceding the target sentence. For instance, the example item in (6) was followed by the comprehension question in (8).

(8) Did Person A mention books about sharks?

When participants chose the wrong Maze word (the foil), they automatically exited the Maze trial and were sent immediately to the comprehension question.

Before being presented with the target stimuli and fillers, participants read a short description of the task, followed by five practice items. Practice items were similar to experimental items in that they involved a short context sentence, followed by a sentence presented in Maze format and a comprehension question. After the short practice phase, the experimental items were presented along with the fillers in a pseudo-random order.

Participants 64 native speakers of English were recruited via Prolific and compensated at a \$12 hourly rate. Data from 56 participants were included in the analysis; 8 participants were excluded because they failed to complete more than 70% of the Maze sentences.

Analysis A Bayesian mixed-effects regression was fit using the *brms* package (Bürkner, 2017) with the default priors. An exgaussian (exponentially modified Gaussian) family was used, following the recommendation given for response times in Bürkner (2020). Exgaussian models are used to fit responses that are believed to be caused by two independent processes: a Gaussian distribution, and a decaying exponential. The models are particularly well-suited to fit the skewed distribution of response times, and the model was therefore estimated using raw RTs (as opposed to log-transformed RTs).

For each model, four chains were run, each with 5000 steps (warmup = 1000 steps). Rhat statistics in all models approached 1.00 and no warnings emerged. Models included the fixed effect focus size (with four levels, contrast-coded, and with the broadest focus condition treated as the reference level), as well as random slopes and intercepts for both subjects and items (Baayen et al., 2008).

Condition	Subject	Verb	NP1	Spillover1	NP2	Spillover2
BROAD	645.46 (12.97)	789.96 (10.72)	739.97 (10.00)	694.23 (8.70)	757.09 (11.13)	743.09 (11.38)
VERB PHRASE	634.50 (8.90)	844.63 (9.79)	815.32 (10.94)	709.70 (10.51)	820.80 (11.64)	775.83 (11.28)
WIDE NP	636.32 (7.06)	797.30 (10.87)	811.35 (10.56)	698.57 (9.35)	833.45 (11.34)	784.75 (16.00)
NARROW NP	627.65 (6.75)	782.67 (10.27)	778.56 (9.83)	706.74 (10.02)	867.96 (12.61)	779.53 (11.38)

Table 4.1: Experiment 5: mean RT and standard error of the mean in each condition per region.

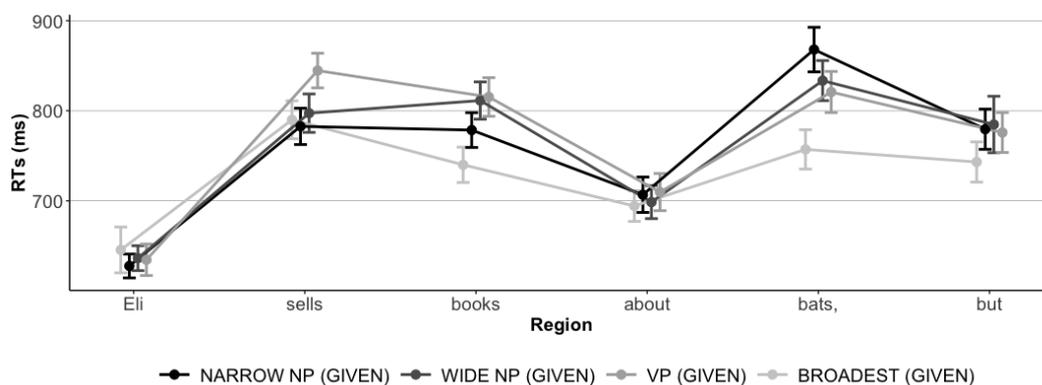


Figure 4.1: Experiment 5: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

4.2.2 Results

Mean response times for the target word and its surrounding regions in all conditions are given in Table 4.1. They are plotted with 95% confidence intervals in Figure 4.1.

The mean comprehension question accuracy was 85%, and the mean completion rate of the maze target sentences of Experiment 5 was 89%.

Table 4.2 presents the posterior estimates of the fixed effects as well as 95% credible intervals for the exgaussian model of Experiment 5. Below, reliable effects on each region will be discussed. No reliable effects were found at either the Subject region, or both Spillover regions.

Verb At the verb, positive estimates for VP focus indicate that response times were reliably slower in the VP focus condition compared to the BROAD focus condition. The credible

		Estimate	Est.Error	l-95%	u-95%	Rhat	Bulk _{ESS}	Tail _{ESS}
Verb	intercept	791.50	13.99	763.44	818.76	1.01	513	1085
	NARROW NP	-7.48	9.07	-25.43	9.97	1.00	3041	2595
	WIDE NP	6.27	7.34	-8.07	20.66	1.00	3640	2794
	VP	57.30	8.43	40.90	73.92	1.00	2766	3148
NP1	intercept	754.68	12.12	731.30	778.71	1.00	477	1130
	NARROW NP	23.40	7.02	9.66	37.30	1.00	2911	2886
	WIDE NP	52.13	7.43	37.73	66.82	1.00	2275	3035
	VP	52.64	8.51	35.98	69.53	1.00	2252	2788
NP2	intercept	786.57	13.79	759.67	814.51	1.01	439	735
	NARROW NP	70.01	7.64	55.33	85.91	1.00	2904	2823
	WIDE NP	35.52	7.45	21.49	50.45	1.00	2739	2792
	VP	32.84	8.32	16.63	49.49	1.00	2810	2686

Table 4.2: Population-level effects for the exgaussian model of RTs in Experiment 5, per region.

intervals for the other contrasts overlapped with zero, indicating that there were no reliable differences between either the NARROW NP or the WIDE NP conditions and the BROAD focus conditions.

NP1 At the first noun phrase, positive estimates for VP, WIDE NP and NARROW NP focus indicated that response times were reliably slower in all three conditions compared to the BROAD FOCUS baseline.

NP2 At the second noun phrase, positive estimates for VP, WIDE NP and NARROW NP focus conditions again indicated that response times were reliably slower in all three conditions compared to the BROAD FOCUS baseline.

4.2.2.1 Post-hoc analysis

Data from Experiment 5 suggested that focus slowdowns occur even on given material that does not receive a focal pitch accent: Regardless of the size of the focus, participants already slowed down at the left edge of each focus relative to a broad focus baseline, with

such slowdowns persisting throughout the entire focus marked phrase in all conditions. The only exception to this general pattern of data were the response times found for the NARROW NP focus condition in the NP1 region, in which slowdowns were already observed despite the fact that the preceding question should have put only the second NP in focus. There is a straightforward explanation for this deviation from expectations, however, because in some of the items—in addition to the larger noun phrase which contained both the first and the second noun—the second noun could also function as the direct object of the predicate in the target sentence on its own. For instance, to answer the question in (9a), one could utter the target sentence in (9b), but another straightforward—and perhaps even more natural response to this question would be the sentence in (9c) in which the first noun has been omitted.

- (9) a. **Context:** This soup tastes horrible! Did Kaitlin add an extra tablespoon of salt, or pepper? NARROW NP
- b. **Target:** I think Kaitlin said she added an extra tablespoon of salt, but I might be wrong.
- c. **Possible answer:** I think Kaitlin said she added salt, but I might be wrong.

Especially in the NARROW NP focus conditions, which asked specifically about only those second nouns (*salt* vs *pepper*), an answer which included only the second noun seems natural, if not preferred. One potential explanation of the unexpected pattern of results on NP1 may be that readers anticipated shorter answers than the ones actually given in the target sentences of this experiment. Slowdowns may therefore have occurred because readers expected a focused NP2 as the object of the verb but in fact encountered NP1. Note that shorter answers like these were only possible in the items in which NP2 was in fact

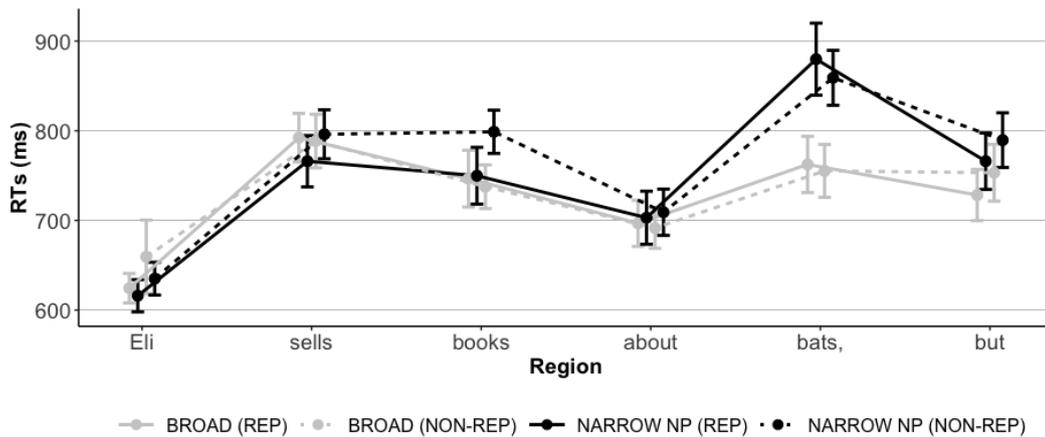


Figure 4.2: Post-hoc analysis of Experiment 5: mean RT in each region in BROAD focus and NARROW NP focus conditions, split by replaceability. Error bars represent the 95% confidence interval.

replaceable for the entire noun phrase. So to test this alternative explanation of the results, a post-hoc analysis was performed in which the data was split on whether or not NP2 could serve as an object to the predicate in each item.

Out of the 60 items of Experiment 5, 36 items contained NP2s that were felicitously replaceable with the larger noun phrase that contained both NP1 and NP2, and 24 were not. Mean RTs with 98% confidence intervals are plotted per item subset in Figure 4.2, comparing the NARROW NP FOCUS condition with the BROAD FOCUS baseline. For each of these item subsets, separate models were run on the response times at the first noun phrase (*books*), which yielded the following results. Crucially, although in the replaceable item set there was a reliable difference between RTs in the NARROW NP and BROAD FOCUS conditions ($\beta = 37.59; CrI = [19.63, 55.92]$), there was no such reliable difference in the non-replaceable item set ($\beta = 4.56; CrI = [-17.75, 28.17]$). In other words, the NARROW NP focus slowdown initially observed at this region disappeared when replaceability of the second noun was accounted for. This may therefore indicate that the NARROW NP effect obtained at the first noun phrase region was indeed driven by these inherent properties of a

subset of the items used in this experiment, rather than the fact that comprehenders generally assigned focus marking to this first noun phrase in this condition.

4.2.3 Discussion

In short, regardless of focus size, focus slowed down reading at the left edge of each focus, with such slowdowns persisting throughout the entire focused phrase. Since the pitch accent in these cases was always assigned at the right edge of a focus, for foci that spanned phrases larger than one word slowdowns were thus observed on material that would be unaccented if pronounced out loud. Moreover, the material of these target sentences was always discourse given and therefore, the observed left-edge focus slowdowns could neither be explained in terms of newness nor in terms of comprehenders slowing down on phrases on which they posit an implicit focal accent during silent reading. However, before concluding that these focus slowdowns are instead due to the underlying focus structure itself, let me briefly consider an alternative hypothesis.

Like the results of Experiment 1 in Chapter 3, one could suggest that focused material in these stimuli, though given, still was unpredictable or unrecoverable given the previous context. Again the questions in Experiment 5 always contrasted two alternatives and target sentences then answered these questions by stating which alternative was true. The relevant notion of predictability, however, cannot correspond to any type of lexical predictability, because the lexical material used in the target sentences was identical across conditions, and this lexical material was always also present in the preceding question. This notion of predictability crucially cannot correspond to mention either, because in each condition the same amount of material in the target sentence was mentioned inside the preceding question. In fact, throughout the target sentence reading times were fastest in the BROAD focus

condition, despite the fact that the context question in this condition mentioned the least amount of material. More overt material in the context did not lead to faster response times overall, and the relevant notion of predictability therefore cannot correspond to givenness or mention per se.

Similarly, cloze probability—i.e., the probability that material in the target sentence would be used in a cloze task—does not capture the right notion of predictability either, again because the answers to these alternative questions would be expected to correspond to either of the two provided disjuncts in those questions. In fact, after having read the verb in VP focus condition the lexical material of the NP1 and NP2 regions should be highly predictable in this sense, because as an answer to the question whether Eli sells books about penguins or writes magazines about whales, reading the word *sell* should already be enough to predict the remainder of the answer, i.e., *books about penguins*. Despite this, in the VP focus conditions reading times on NP1 and NP2 remained comparable to the NARROW NP and WIDE NP focus conditions on these regions.

Instead, in order to explain the left-edge slowdowns on foci we need to somehow make reference *entailment from the common ground*, as I outlined in the previous chapter. The left edge of each focused phrase corresponded to the left edge of material that provided the answer to the preceding question, and can therefore be thought of as most unpredictable in the sense that it expressed the information that was not entailed by the question.

One advantage of using this notion of entailment to explain these effects is that it would not only provide a straightforward explanation of the *reason* that these slowdowns were observed (here and elsewhere), but it can simultaneously account for the fact that the location of foci is anticipated based on preceding context. This is because, by virtue of signalling which information is still unanswered, questions also allow comprehenders to pre-

dict which subsequent material is non-entailed. For instance, in answers to *wh*-questions, comprehenders know that it is the phrase that corresponds to the *wh*-phrase that provides the information that would answer these questions, while it is also this information that is left undecided by that question. In the presence of a preceding question, comprehenders know *where* to find the material that answers it, although they may not yet know *what* that material looks like exactly. The assumption that comprehenders thus track what questions are being asked in discourse and what potential answers to these questions may look like, could simultaneously account for the fact that listeners are able to predictively allocate more attention to such answers (e.g., Cutler & Fodor, 1979), and the fact that readers slow down on such answers in reading (as is suggested by the present data, as well as Benatar & Clifton 2014).

However, in the next section I will show that even this more general notion of discourse entailment is insufficient to fully account for the way focus is assigned and the observed slowdowns on foci themselves, because such slowdowns can still be observed on foci that did not provide answers to an explicit question. Experiment 6 and Experiment 7 also show that the reading profile of focus extends to that of second-occurrence foci, which are both discourse-given and entailed by their contexts. Together, these experiments therefore show that the assignment of focus marking takes place even for contrastive foci which are put in focus not by virtue of forming an answer to a question but by virtue of contrasting with a previously mentioned alternative. In the next section, I outline why second-occurrence foci are the right test case for the question at hand by further outlining the predictions of an account of focus processing in which both the assignment and interpretation of focus crucially depends on a contextually salient set of alternatives.

4.3 Probing the abstract representations involved in focus processing

Although one potential explanation for the focus slowdowns obtained in Experiment 5 (and those in Chapter 3) may be that readers generally slow down on answers to questions because answers typically constitute unpredictable or non-entailed information, Experiment 6 and Experiment 7 will show that effects of focus can even be observed in the absence of an explicit question, and even when focused material is already entailed by its preceding context. An account of these data therefore cannot make reference to any notion of predictability, and suggests that instead, it must be the assignment of the abstract underlying focus structure itself that drives participants' reading behavior.

Existing behavioral evidence indeed suggest that foci may be anticipated in light of explicitly mentioned contrastive alternatives. For instance results from a self-paced reading paradigm by Sedivy (2002) showed that the presence or absence of contrastive alternatives in a context sentence, as in (10a–b), affected parsing decisions in temporarily ambiguous sentences like (10c–d).

(10) **Context:**

- a. All of the secretaries and accountants were made to take a tough computing course. Contrast
- b. All of the secretaries in the company were made to take a tough computing course. No contrast

Target:

- c. Only the secretaries / prepared / for the exam / and earned / significant / pay

raises.

Main

- d. Only the secretaries / prepared / for the exam / passed / and earned / pay raises.

Reduced relative

The presence of such an explicit contrast set in the context and the continuation of an ambiguous fragment, as either a main clause or reduced relative, reduced reading times on the critical region (*passed*), indicating that the garden path effect was modulated by contextual mention of contrastive alternatives. Readers thus anticipated the focus based on information about contrastive alternatives in the discourse context.

I will therefore argue that the on-line assignment of focus takes place via comprehenders' representation of alternatives that contrast with the expression in focus. Below, I first discuss what such an abstract representation of focus may look like by further outlining an account of focus that defines it in terms of contrastive alternatives. Then, I highlight what specific predictions such an account makes for both the assignment and the interpretation of foci.

4.3.1 Background on focus in Alternative Semantics

Foci do not always constitute unpredictable information because it is the notion of alternatives, and not that of newness or unpredictability, through which they are defined. Contrastive foci such as *book* in (11b), for instance, are focused by virtue of being contrasted with a previously mentioned phrase, i.e., *article* in (11a).

- (11) a. **Speaker A:** Sarah read an article about bats.
b. **Speaker B:** No, Sarah read a [BOOK]_F about bats.

Expressions can also be focused because they are bound by a focus particle like *only* as shown in (12) and (13).

(12) Sarah only read a [BOOK]_F about bats. (not an article)

(13) Sarah only [READ]_F a book about bats. (she didn't write one)

Prominent theories of focus capture the fact that question/answer focus, contrastive focus and bound focus is marked by an accent by suggesting that all these types of foci make reference to the intuitive notion of *contrastive alternatives*—expressions that contrast with and could possibly replace the expression in focus.

It is easy to see why a notion of alternatives is needed for bound foci. Intuitively, the meanings of focus particles refer to alternate versions of the sentence that differ solely in the position of focus. For *only*, all of these alternatives are negated, except for the one that is identical to the sentence in which it appears. Thus, while the sentence in (12) conveys that Sarah did not read any other things about bats besides a book, the sentence in (13) implies that Sarah did not do any other things with books about bats besides reading them.

Alternatives are also involved in the interpretation of free foci, where they function to identify what question is being answered, or—for contrastive foci like (11b)—to signal what explicitly mentioned phrase a focus contrasts with.

The observation that focus determines which alternatives an utterance makes reference to was first captured in Rooth's (1992a) *Alternative Semantics*, in which every utterance comes with its regular meaning (the "ordinary semantic value", denoted by $\llbracket \]^o$), and a second meaning representation, a set of alternatives ("the focus-semantic value", denoted by $\llbracket \]^f$). The focus-semantic value of an expression is determined by substituting alter-

native meanings for constituents that are focused. For example, the focus–semantic value (14) is the set of propositions in (14b), while the focus semantic value of (15) is the set of propositions in (15b).

(14) Sarah only read a [BOOK]_F about bats

- a. $\llbracket(14)\rrbracket^o = \lambda w. \text{ Sarah read a book about bats in } w$
- b. $\llbracket(14)\rrbracket^f = \{\lambda w. \text{ Sarah read a } \mathbf{book} \text{ about bats in } w, \lambda w. \text{ Sarah read an } \mathbf{article} \text{ about bats in } w, \lambda w. \text{ Sarah read a } \mathbf{magazine} \text{ about bats in } w, \dots\}$

(15) Sarah only [READ]_F a book about bats.

- a. $\llbracket(15)\rrbracket^o = \lambda w. \text{ Sarah read a book about bats in } w$
- b. $\llbracket(15)\rrbracket^f = \{\lambda w. \text{ Sarah } \mathbf{read} \text{ a book about bats in } w, \lambda w. \text{ Sarah } \mathbf{wrote} \text{ a book about bats in } w, \lambda w. \text{ Sarah } \mathbf{edited} \text{ a book about bats in } w, \dots\}$

The placement of the accent thus determines which phrase is focus marked, which in turn affects the alternatives that are evoked. The meaning of *only* depends on such alternatives because it negates all focus alternatives except for the one in the ordinary value of these sentences. Different focus structures therefore result in distinct interpretations, as shown in (16) and (17).

(16) Sarah only read a [BOOK]_F about bats.

- a. $\rightsquigarrow (\text{Sarah read a } \mathbf{book} \text{ about bats})$
- b. $\rightsquigarrow \neg (\text{Sarah read an } \mathbf{article} \text{ about bats})$
- c. $\rightsquigarrow \neg (\text{Sarah read a } \mathbf{magazine} \text{ about bats})$

(17) Sarah only [READ]_F a book about bats.

- a. \leadsto (Sarah **read** a book about bats)
- b. $\leadsto \neg$ (Sarah **wrote** an article about bats)
- c. $\leadsto \neg$ (Sarah **edited** a magazine about bats)

The notion of alternatives also helps account for the general principle of question/answer congruence that governs the placement of answer foci—i.e., the fact that well-formed answers to wh-questions generally include foci which correspond to the wh-item in the preceding question, as we have seen in Section 4.1.1. The relevant examples are repeated here in (18) and (19).

- (18) a. **Speaker A:** What about bats did Sarah read?
 b. **Speaker B:** Sarah read a [BOOK]_F about bats.
 c. **Speaker B:** #Sarah [READ]_F a book about bats.

In a widely adopted semantics of questions (Hamblin, 1973), the meaning of wh-questions denote the set of their possible answers, which can be derived from substituting the wh-word with a variable that ranges over type-appropriate alternatives. The question in (18a) therefore denotes the sets of propositions in (19).

- (19) $\llbracket (18a) \rrbracket^o = \{\lambda w. \text{Sarah read } x \text{ about bats in } w \mid x \in D_e\}$

Note that this set contains the same alternatives as the alternative set denoted by the focus semantic value of its well-formed answer, as was shown in (14b). With a notion of alternatives, question/answer congruence can therefore be explained as resulting from the general requirement that the alternatives evoked by an answer correspond to the alternatives made salient by the preceding question.

In Rooth's theory in particular, the fact that the alternatives evoked by a focus depend on context is captured by adopting a presuppositional focus operator \sim , which introduces the presupposition that the focus alternatives of an expression need to be a subset of some set of alternatives that is salient in the context. More formally, \sim takes two arguments: the set of focus alternatives of the constituent it attaches to, and an unpronounced pronoun C which picks up on a salient set of alternatives in the context. It then introduces the presupposition that the antecedent of C is a subset of that focus semantic value $\llbracket \varphi \rrbracket^f$, thereby establishing a correspondence between a contextually salient set of alternatives and the alternatives evoked by the focus itself.

(20) **Rooth's \sim operator:**

$\llbracket \varphi \rrbracket \sim C$ presupposes that $C \subseteq \llbracket \varphi \rrbracket^f$ (simplified version)

When attached to (18b) as shown in (21), this operator ensures that the set of alternatives evoked by the focus *book* is a subset of the alternatives made salient by the preceding question:

(21) $\llbracket \text{Sarah read a [BOOK]}_F \text{ about bats} \rrbracket_\varphi \sim C$ presupposes that $C \subseteq \llbracket (21) \rrbracket^f$

- a. $\llbracket \varphi \rrbracket^f = \{\lambda w. \text{ Sarah read a } \mathbf{book} \text{ about bats in } w, \lambda w. \text{ Sarah read an } \mathbf{article} \text{ about bats in } w, \lambda w. \text{ Sarah read a } \mathbf{magazine} \text{ about bats in } w, \dots\}$
- b. $C = \{\lambda w. \text{ Sarah read } x \text{ about bats in } w \mid x \in D_e\}$

When (21) is answered in response to (18a), this presupposition is satisfied, because the alternative set made salient by the question is indeed a subset of the alternatives in the focus value of this sentence in (14b). But when the sentence in (18c) is given as a response to the

same question, this presupposition is not satisfied, leading to infelicity.

By making reference to alternative sets, such an account of focus can also capture the placement of contrastive foci as in (22), which signal a contrast with a previously mentioned alternative.

- (22) Lily [read an article about bats], and Sarah [read a [BOOK]_F about bats]_ψ ~ C
- a. $\llbracket \psi \rrbracket^f = \{\lambda x \lambda w. x \text{ read a } \mathbf{book} \text{ about bats in } w, \lambda x \lambda w. x \text{ read an } \mathbf{article} \text{ about bats in } w, \lambda x \lambda w. x \text{ read a } \mathbf{magazine} \text{ about bats in } w, \dots\}$
- b. $C = \{\lambda x \lambda w. x \text{ read a } \mathbf{book} \text{ about bats in } w, \lambda x \lambda w. x \text{ read an } \mathbf{article} \text{ about bats in } w, \dots\}$

For these types of foci, the contextually salient set of alternatives that *C* picks up on is a set which contains at least the focus itself and that previously mentioned alternative, as shown in (23b). Note that (22) is also an example where ~ attaches to a constituent that is smaller than a clause: it attaches to the phrase *read a book about bats*, because this is the phrase that contrasts with the previously mentioned phrase *read an article about bats*.

The crucial assumption in Rooth's account of focus is that any focus comes with a ~ operator, even for bound foci like (12) and (13). This predicts that the placement of bound foci, like that of question/answer and contrastive foci, is context-dependent, too. Indeed, the placement of bound foci may also depend on the presence of a preceding question, or the presence of a contextually overt alternative as shown in (23).

- (23) Lily read an article about bats, but Sarah only [read a [BOOK]_F about bats] ~ C
- (Sarah did not read an article about bats)

- a. $\llbracket \psi \rrbracket^f = \{\lambda x \lambda w. x \text{ read a } \mathbf{book} \text{ about bats in } w, \lambda x \lambda w. x \text{ read an } \mathbf{article} \text{ about}$

bats in w , $\lambda x \lambda w. x$ read **a magazine** about bats in w, \dots }

- b. $C = \{ \lambda x \lambda w. x$ read **a book** about bats in w , $\lambda x \lambda w. x$ read **an article** about bats in w, \dots }

The example in (23) again has an underlying structure in which the preceding clause again makes salient a set of alternatives that is interpreted as the antecedent for C , just as we saw for the contrastive focus in (22). Here too, the inclusion of \sim therefore ensures focus marking is placed such that the set of evoked alternatives contains at least the alternative *read an article about bats* that was mentioned in the preceding clause.

In short, context-dependence is thus a general property of focus marking, which is captured in Alternative Semantics by treating focus as introducing a pronominal anaphor C . Although not all theories of focus are formalized using an actual pronoun, most theories of focus still assume that there is a general dependency between foci and their preceding contexts. Therefore, adopting any of these formal representations predicts that the assignment of focus in incremental processing must in some way be governed by its context. This has several consequences for the way focus may be processed.

First, it predicts that the process of focus assignment is guided, not just by the presence of explicit questions, but by any contextual material that may provide an antecedent for a focus by making a set of alternatives salient. And therefore, while answers to explicit questions are typically not entailed by their context, this is not a requirement for focus as defined in terms of alternative sets. The hypothesis that slowdowns on foci in Experiment 5 were observed because comprehenders anticipate answers to questions which are unpredictable in this sense, can thus be contrasted with one in which it is the computation of alternatives that guides the assignment of focus structure and therefore also plays a central role in the

slowdowns observed on foci. Both Experiment 6 and Experiment 7 will test the processing of foci that are focused by virtue of evoking alternatives, but not by providing unrecoverable answers to preceding questions. Here, I in fact argue that these experiments show that in on-line processing, the dependence between the focus structure of sentence and its context can in fact be forward-looking, i.e. that the assignment of focus can be guided by context even before the focus itself is encountered.

Second, an alternative-based account of focus predicts that the inferences typically attributed to focus marking still arise when foci are given and are fully entailed by their context. For instance, in (24b), *book* expresses information which is already entailed by its context and does not answer the preceding question. And yet this sentence still conveys that Sarah did not read any alternatives to books such articles or magazines, like the sentence in (23).

- (24) a. **Speaker A:** Which student only read a [BOOK]_F about bats?
b. **Speaker B:** [SARAH]_F only read a [book]_F about bats. (not an article)

With focus defined in terms of contrastive alternatives, the inferences arising from (24b) can be accounted for because *book* can still be considered focus marked by virtue of signalling what alternatives it makes reference to.

Foci like these will be crucial in probing the representations that are involved in focus marking, because these foci allow us to investigate what role alternatives play in the way focus is processed and in the way focus structure is assigned to a sentence during silent reading. Since such foci refer to alternatives without being unpredictable, new or non-entailed by their contexts, they also allow us to test why there may be a general cost for the processing of foci, as has been argued in Chapter 2. If readers still slow down on

these foci, this would indicate that there is a cost for the processing of focus itself that could only be explained by making reference to the abstract representations involved in its interpretation, rather than by making reference to a cost for incorporating material that is new or unpredictable in some other way.

Finally, because this understanding of focus in terms of alternative sets involves abstract representations, it also predicts that sentences may involve a focus structure that is more complex than simply dividing a sentence into those parts that are given and new, or those parts that do and do not answer a preceding question. For instance, there is nothing in the theory of focus outlined above that would prevent multiple foci to co-occur within a single sentence. In Rooth's account, \sim operators may even be nested within the domain of another \sim . In those cases, each \sim operator introduces its own presupposition, and therefore its own dependency between its focus and the preceding context. The possibility of such nested \sim operators in fact plays an important role in accounts of contrastive topics (Wagner, 2008; Tomioka, 2009, 2010; Wagner, 2012) and second-occurrence focus (Rooth, 2010; Büring, 2015)—an example of which has already been given in (24).

These types of foci also have the potential to reveal the limits of the complexity of the mental representations involved in focus processing. More examples of second-occurrence foci as well as their implications for the on-line comprehension of focus, will be further discussed in the next section.

4.3.2 Second-occurrence foci as a test case

Experiment 6 and Experiment 7 will probe the processing of second-occurrence in sentences like (25b).

(25) a. Speaker A: Bob read a book about whales and penguins, and Sarah only read

a book about [BATS]_F

b. Speaker B: No, LILY_{F2} only read a book about [BATS]_{F1} .

Sentences like (25b) have several properties which make them well-suited for the present purposes. These sentences were first discussed by Partee (1999) and have since risen to fame mainly because only the focus on *Lily* is marked by a pitch accent, but not the focus on *bats* bound by *only*. The lack of an accent on *bats* is an issue for most theories of focus because, as pointed out by D. I. Beaver & Clark (2008), the focus particle *only* conventionally associates with a focus in its scope. Without the presence of focus marking which evokes a set of alternatives, the meaning of *only* therefore cannot be computed. Even though it does not receive an accent, it must therefore be that *bats* in (25b) is still underlyingly focus marked, evoking a set of alternatives that is operated on by *only*. This is surprising because even for foci like those in Experiment 5—which crucially also contain non-accented material as well—a pitch accent is still reliably assigned to the most prominent syllable within them, unlike SO foci like *bats* which do not receive an accent at all.

Most accounts of SOF explain this mismatch between the interpretation and the realization of SO foci by making reference to the fact that these foci have typically been mentioned as regular foci before their occurrence as an SOF, as is the case in (24a) (Selkirk, 2007; Rooth, 2010; Beaver & Velleman, 2011). These two properties of SO foci (non-accenting and givenness) make them particularly suitable foci for our present purposes, because like in Experiment 5, these foci allow us to measure effects of focus marking that cannot be due to material being new or marked with a pitch accent.

But unlike the foci in Experiment 5, these second-occurrence foci are not answers to questions, nor are they unpredictable in some other way. The utterance that (25b) responds

to already states that someone only read a book about bats. Therefore, it does not just make the entire phrase *only read a book about bats* given, it also makes it already entailed by the discourse context. SOF examples like these are therefore a good test case to study whether the previously observed slowdowns on foci are due to the them being unpredictable given the preceding discourse, or whether they are due to the fact that focus marking is assigned to the abstract representation of these sentences. For instance, although the formal representation of sentences like (25b) may have to involve focus marking on *bats*, it may still be that readers do not slow down on this phrase when it is a SOF, because effects previously attributed to focus marking are not actually observed on focused material that is fully recoverable in its context.

Another crucial property of these sentences is that they contain multiple foci which each serve a distinct purpose. More concretely, in Rooth's (2010) account of SOF the sentence in (25b) contains two foci (*Lily* and *bats*), which are each associated with their own \sim operators (see also Büring, 2015), as shown in (26).

- (26) a. Speaker A: Bob read a book about whales and penguins, and Sarah only [read a book about [BATS]_F] $\sim C_1$
- b. Speaker B: No, [_{S₂} LILY_{F2} only [_{S₁} read a book about [bats]_{F1}] $\sim C_1$] $\sim C_2$

Each of these foci evoke their own set of alternatives: alternatives evoked by the focus on *Lily* are those in (27a) and alternatives evoked by *bats* are those in (27b).

- (27) a. $\llbracket S_2 \rrbracket^f = \{ \lambda w. \mathbf{Lily}$ only read a book about bats in w ,
 $\lambda w. \mathbf{Sarah}$ only read a book about bats in $w, \dots \}$
- b. $\llbracket S_1 \rrbracket^f = \{ \lambda x \lambda w. x$ read a book about **bats** in w ,

$\lambda x \lambda w. x$ read an article about **whales** in w, \dots }

In (26b), the focus on *Lily* is anaphoric to the preceding sentence in (26a) under this account, by virtue of contrasting with *Sarah*. The antecedent of C_2 that is associated with this focus contains at least the alternatives in (27a). The focus on *bats* cannot pick up on the same focus antecedent as it evokes a set of alternatives that is distinct from the ones evoked by *Lily*. Such sentences thus require there to be multiple distinct sets of alternatives that are salient within the context, and complex cases like these could therefore potentially reveal how comprehenders deal with such alternative sets. A comparison between new and SO foci, in particular, may allow us to test whether comprehenders encode and maintain multiple alternative sets during their incremental assignment of focus structure, or whether it is only the alternative sets of new foci that guide this process.

In fact, SOF also allow us to probe what exact role the computation of alternatives plays within the comprehension of focus. As outlined in Chapter 2, perhaps readers slow down on foci not only because they are updating their representation of the discourse context with incoming information provided by the focus itself, but also because they have to compute what the relevant alternatives to a focus are. It may be that the slowdowns that were observed in Benatar & Clifton (2014) and Hoeks et al. (2023), for instance, arise in part because comprehenders actively inhibit their representations of alternatives to the one in focus. For SO foci it is not just the case that the focus itself is given, but the alternatives that are evoked have also already been computed during the interpretation of the previous discourse. For instance in both (26a) and (26b), the particle *only* operates over the set of alternatives in (27b), negating alternative statements about types of things that could have been read about instead of bats. If the behavioral effects observed on foci are due to the

computation of alternatives, we would expect such effects to be diminished on SO foci because alternatives to these types of foci have already been computed in the prior discourse.

In short, if slowdowns on SO foci like those in (27b) can still be observed, this suggests that it is the abstract representation of focus, in reference to its alternatives, that causes these slowdowns, because despite the fact that SO foci are focus marked and evoke a set of contrastive alternatives these foci themselves are also fully predictable: they are given, and these foci themselves—as well as the alternatives and inferences deriving from them—are already entailed by the preceding context.

4.4 Experiment 6

The goal of Experiment 6 was twofold. First, it aimed to show that the focus structure of a sentence can be manipulated via the presence of contrastive expressions in the preceding context, which may implicitly evoke a set of alternatives but does not make explicit reference to a question. Results from this experiment indeed confirmed that slowdowns can be found on a bound focus whose exact location and size was determined via the presence of such contextual alternatives, indicating that salient alternatives in the context can guide focus structure that is projected by readers on subsequent material.

Second, Experiment 6 was also designed to investigate whether the representation of such alternative sets can affect reading times even if the material that is being read is already entailed by the context and is therefore entirely recoverable and predictable from that context. Results indicate that left-edge slowdowns can be found even for such second-occurrence foci that represent such predictable information, suggesting that the slowdowns on foci cannot solely be explained in terms of predictability. Instead, results suggest that salient sets of alternatives not only guide comprehenders in their assignment of focus struc-

ture, but must also underlie the slowdowns on material that has been assigned focus marking.

4.4.1 Method

Materials In Experiment 6, every item constituted a dialogue between two speakers, *Speaker A* and *Speaker B*, where the utterance by *Speaker B* was considered the target sentence and the utterance of *Speaker A* served as the context sentence against which the target sentence was interpreted. The target sentence, uttered by *Speaker B*, always contained the focus particle *only* which was placed inside that sentence in a position in which its associate could either be a narrow or a wider focus. The preceding context sentence then manipulated both the Size (NARROW vs WIDE) of that focus as well as its Type (NEW vs SOF). This sentence always consisted of two clauses in which two alternatives were contrasted with each other, and focus Size was therefore manipulated by the size of these alternatives, such that in the NARROW conditions only single nouns were contrasted while in the WIDE conditions noun phrases consisting of two nouns were contrasted with each other. Orthogonal to this manipulation of focus Size, the utterance of *Speaker A* also manipulated focus Type since it determined whether the focused phrase uttered by *Speaker B* was either NEW or second-occurrence (SOF). An example item in all four conditions is shown in (28).

- (28) a. **Speaker A:** Abby read a book about penguins and whales,
and Bob read a book about [gorillas]_F
Speaker B: And Lily only read a book about [bats]_F NARROW NEW
- b. **Speaker A:** Abby read an article about penguins and a report on whales,
and Bob read [an article about gorillas]_F
Speaker B: And Lily only read [a book about bats]_F WIDE NEW

- c. **Speaker A:** Abby read a book about penguins and whales,
and Bob only read a book about [bats]_F
Speaker B: No, [Lily]_F only read a book about [bats]_F NARROW SOF
- d. **Speaker A:** Abby read an article about penguins and a report on whales,
and Bob only read [a book about bats]_F
Speaker B: No, [Lily]_F only read [a book about bats]_F WIDE SOF

In all conditions, the first object noun in the target sentence (*book*) constituted the critical region of interest, because—if focus structure in the context affected focus structure on the target sentence—it is this region that would either be focused (in the WIDE conditions) or not (in the NARROW) conditions. Since the material inside the target sentence was held constant across conditions, response time differences in this region between the WIDE and NARROW conditions would thus indicate a difference in the projected focus structure of this sentence. In total, 48 items were constructed, each with the four conditions illustrated in (28). All items for Experiment 6 can be found in Appendix II. Another 64 filler items which also consisted of multi-line discourses were interspersed with test stimuli. Using a Latin Square design, all 48 items were counterbalanced over 4 lists, such that each participant saw one condition from every item.

Procedure The procedure of Experiment 6 was largely identical to that of Experiment 5, with target sentences being presented in the Maze task and context sentences presented on a separate screen prior to the presentation of the first word of the target sentence. Comprehension questions again targeted aspects of the context to ensure careful reading of this material.

The five practice items were identical to those of Experiment 5, and again resembled

Condition	Subject	Particle	Verb	NP1	NP2
NEW NARROW	834.10 (23.74)	803.18 (14.11)	696.93 (11.48)	789.48 (13.22)	954.33 (15.80)
NEW WIDE	810.50 (17.55)	844.61 (17.10)	728.04 (16.33)	936.04 (17.26)	939.57 (20.26)
SOF NARROW	971.72 (31.47)	753.85 (14.45)	704.20 (12.08)	774.20 (14.89)	862.86 (16.41)
SOF WIDE	947.68 (25.50)	771.36 (14.67)	714.24 (12.70)	859.30 (17.59)	886.34 (16.95)

Table 4.3: Experiment 6: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

the experimental items in that they involved a short context sentence, followed by a sentence presented in Maze format and a comprehension question. After the practice phase, the experimental items were presented along with the fillers in a pseudo-random order.

Analysis Data were analyzed using R, version 3.6.3 (R Core Team, 2021). Bayesian (generalized) linear mixed-effect models were fit using Stan, as implemented in the brms package, version 2.18.0 (Bürkner, 2017), with the default priors. Separate models were fit to log-transformed response times and untransformed response times as dependent measures. For each model, we ran four chains, each with 5000 steps (warmup = 1000 steps). Rhat statistics in all models approached 1.00 and no warnings emerged. Models included population-level effects of focus and newness (contrast-coded), with NARROW focus and NEW conditions treated as reference levels, and random slopes and intercepts for both subjects and items (Baayen et al., 2008).

4.4.2 Results

The mean comprehension question accuracy was 79%, and the mean completion rate of the maze target sentences of Experiment 6 was 89%. Mean response times for each region of the target sentence in all conditions are given in Table 4.3. They are plotted with 95% confidence intervals in Figure 4.3.

Table 4.4 and 4.5 present the posterior estimates of the fixed effects as well as 95%

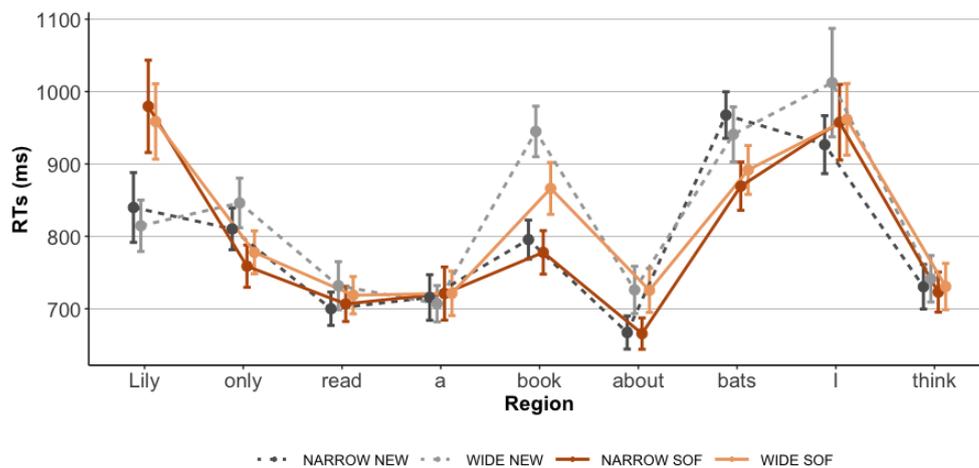


Figure 4.3: Experiment 6: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

credible intervals for both models of Experiment 6. Below, reliable effects on each region will be discussed. No reliable effects were found at either the verb region, or the Spillover regions of NP2.

Subject On the subject (*Lily*), positive estimates for focus Type indicate that subjects in the SOF conditions were read reliably slower than subjects in the NEW focus conditions.

Particle On the particle (*only*) positive estimates for Type indicate that the particle in the SOF conditions was read faster than particles in the NEW focus conditions.

NP1 On the first NP (*book*), positive estimates for focus Size indicate that this noun was read faster in the wide conditions than the narrow conditions, and positive estimates for focus Type indicate that SOF foci were read faster than NEW foci. There was also a reliable interaction between focus Size and focus Type, though the focus Size effect was reliable among both the SOF ($\beta = 71.89$, 95%CrI=[140.59,3.51]) and the NEW conditions ($\beta = -168.11$, 95%CrI=[-242.04,-94.73]).

		Estimate	Est.Error	95%CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
Subj	Intercept	2.90	0.01	[2.87, 2.93]	1.00	1428	3026
	Size	-0.03	0.01	[-0.04,-0.01]	1.00	9500	11262
	Type	-0.00	0.01	[-0.01, 0.01]	1.00	22491	13237
	Size:Type	-0.00	0.01	[-0.03, 0.02]	1.00	15398	12918
Part	Intercept	2.87	0.01	[2.84,2.89]	1.00	1603	3335
	Size	0.03	0.01	[0.02,0.04]	1.00	13268	12734
	Type	0.01	0.01	[-0.00,0.02]	1.00	14628	13245
	Size:Type	0.00	0.01	[-0.02,0.02]	1.00	20815	13235
NP1	Intercept	2.90	0.01	[2.87,2.92]	1.00	1628	3716
	Size	0.03	0.01	[0.02,0.04]	1.00	14582	12793
	Type	0.05	0.01	[0.03,0.07]	1.00	8845	11498
	Size:Type	0.04	0.01	[0.01,0.06]	1.00	12572	11390
NP2	Intercept	2.93	0.01	[2.90, 2.96]	1.00	1292	2967
	Size	-0.00	0.00	[-0.01, 0.01]	1.00	12301	11457
	Type	0.04	0.01	[0.03, 0.05]	1.00	6968	9803
	Size:Type	-0.02	0.01	[-0.04, 0.00]	1.00	18513	12971

Table 4.4: Posterior estimates for the population-level effects of logRTs in Experiment 6, per region.

		Estimate	Est.Error	95%CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
Subj	Intercept	886.08	38.17	[811.17,961.00]	1.00	4053	6845
	Size	-136.88	25.41	[-187.40,-86.88]	1.00	17946	12633
	Type	-23.16	30.39	[-82.98, 36.71]	1.00	19309	13598
	Size:Type	1.33	52.34	[-100.18,104.81]	1.00	22771	13235
Part	Intercept	792.85	30.91	[732.00,854.47]	1.00	2100	3602
	Size	61.02	17.93	[25.73, 96.94]	1.00	19853	12824
	Type	29.11	14.52	[0.71, 57.78]	1.00	27777	11646
	Size:Type	24.85	31.31	[-35.32, 86.93]	1.00	13889	11859
NP1	Intercept	884.00	38.94	[807.38,961.64]	1.00	705	1400
	Size	51.90	21.26	[9.50, 94.13]	1.00	4981	3111
	Type	120.00	28.62	[64.07,174.68]	1.00	3469	2690
	Size:Type	96.22	44.93	[7.94,185.74]	1.00	5106	2888
NP2	Intercept	908.71	20.87	[867.72,949.13]	1.00	1262	2718
	Size	-9.27	8.61	[-26.34, 7.34]	1.00	7039	10379
	Type	62.81	10.39	[42.24, 83.54]	1.00	6322	10847
	Size:Type	-14.10	15.25	[-43.72, 15.67]	1.00	14085	11694

Table 4.5: Posterior estimates for the population-level effects of raw RTs in Experiment 6, per region.

NP1 spillover Positive estimates for Size on the NP1 spillover region again indicate that the this phrase was read faster in the NARROW conditions than in the WIDE focus conditions. The estimated credible interval for the main effect of focus Type as well as for the interaction between focus Type and Size overlapped with zero so these estimates will not be considered reliable in this region.

NP2 On the second NP (*bats*), positive estimates for focus Type again indicate that NP2 read slower in the second occurrence focus conditions than in the new focus conditions, but the estimates for focus Size, as well as the interaction effect, was not reliable.

4.4.3 Discussion

Like in Experiment 5, reading times were affected by the manipulation in focus Size, such that slowdowns were found on the first NP in the WIDE focus condition compared to the NARROW focus condition. Again, this may suggest that such slowdowns were caused by the underlying focus structure that was assigned to these sentences rather than by the fact that an accent was anticipated, because slowdowns occurred at the left edge of each focus which would not receive an (implicit) accent. Since Experiment 6 manipulated the size of these foci via the alternatives that were mentioned in the context and not via an explicit question, these focus slowdowns also could not be explained as arising because comprehenders anticipated the answer to an explicit question, unlike the effects in Experiment 5. These results would therefore be in line with the hypothesis that the assignment of focus structure takes place based via comprehenders' representations of alternatives, not just via explicit contextual questions.

Note that the slowdown obtained on the first NP between the NARROW NEW and the WIDE NEW conditions could still in part be explained as a cost for updating the answer to an *implicit* question that is inferred from context. Focused material in these conditions was both new and discourse unpredictable and may have been signalled to be so by virtue of contrasting with previously mentioned alternatives. This was crucially not the case for the foci in the SOF conditions, however, in which focused material did not provide new or unrecoverable information. And although the SOF focus slowdown on this region was smaller than the NEW focus slowdown, the SOF slowdown was still reliable, indicating that the focus slowdown cannot entirely be explained in terms of a cost for updating new or unrecoverable material.

One remaining possibility is that the SOF slowdown on NP1 does not indicate the

assignment of focus marking, but instead indicates that readers slowed down because they expected new material in those regions even though those regions were in fact always given in these conditions. However, since the only difference between the NARROW SOF and WIDE SOF conditions in particular was the size of the alternatives that were mentioned in the preceding context, reading times in these conditions could only have been affected by this contextual manipulation. Readers could therefore only have formed such expectations based on these alternatives in the context. Any explanation of this effect would thus need to make reference to such alternatives, which would entail that some representation involving these alternatives guides readers' downstream behavior.

One question that could be raised is *when* contextually mentioned alternatives become relevant. That is, what is it exactly that prompts comprehenders to encode information about alternatives in the first place? For instance, in the materials of Experiment 6, the focus particle may provide a clear cue for comprehenders to assign a focus somewhere following it. The presence of *only* in the SOF conditions may therefore have triggered comprehenders to revisit their representation of the context in order to determine what the focus and its alternative set looks like. After all, the inferences that *only* contributes depend on these alternatives and the basic meaning of these sentences cannot be computed without knowing what the relevant alternatives are. This process would perhaps not take place if such a clear cue to the need for focus marking (and the need for the computation of alternatives) would not be present.

Alternatively, it may be that comprehenders already encode what alternative sets are relevant in these discourses before they reached the focus particle, for instance because the encoding of alternative sets is an integral part of discourse processing more generally. Contextual contrasts may help comprehenders encode what the relevant alternative sets look

like. In that case, the assignment of focus takes place based on such previously encoded alternative set and although the meaning of focus-sensitive particles may require the encoding of alternatives to compute the relevant inferences, the presence of such particles is not necessary to trigger this process. Experiment 7 therefore tests whether an effect of contextually mentioned alternatives can still be observed when the focus particle was removed from the target sentence, in order to better understand the process through which alternative sets are dealt with during the comprehension of discourse.

4.5 Experiment 7

The goal of Experiment 7 was first to replicate the second-occurrence focus slowdown from Experiment 6 and second to test whether such a slowdown would also occur when there is no particle present in the target sentence that could explicitly prompt the calculation of alternatives to the focus it binds.

4.5.1 Method

Materials The materials of Experiment 7 were adapted from those of Experiment 6. Again, context sentences manipulated the Size of the focus in the target sentence via the inclusion of alternatives. However, this time all target sentences were such that only the subject provided new information while the rest of the target sentence was both given and recoverable from the preceding context. Orthogonal to this manipulation of focus Size, the presence of a focus Particle was manipulated such that target sentences either did or did not contain the particle *only*. Therefore, the target region (*book*) was either the second occurrence of a BOUND focus or the second occurrence of a FREE focus, as shown in (29).

- (29) a. **Speaker A:** Abby read a book about penguins and whales,
and Bob read a book about [bats]_F
Speaker B: No, [Lily]_F read a book about [bats] FREE, NRRW
- b. **Speaker A:** Abby read an article about penguins and a report on whales,
and Bob read [a book about bats]_F
Speaker B: No, [Lily]_F read [a book about bats] FREE, WIDE
- c. **Speaker A:** Abby read a book about penguins and whales,
and Bob only read a book about [bats]_F
Speaker B: No, [Lily]_F only read a book about [bats]_F BOUND, NRRW
- d. **Speaker A:** Abby read an article about penguins and a report on whales,
and Bob only read [a book about bats]_F
Speaker B: No, [Lily]_F only read [a book about bats]_F BOUND, WIDE

Procedure As in Experiment 6, target sentences were implemented in the Maze task. Maze foils for Experiment 7 were adapted from those generated using the AutoMaze algorithm, where the foil for *only* was removed from the materials of the SOF conditions of Experiment 6 to create the FREE SOF foils of Experiment 7. Completion of the experiment took roughly one hour including the practice phase.

Participants 52 native speakers of English were recruited via Prolific and compensated at a \$12 hourly rate. Data from 48 participants were included in the analysis; 4 participants were excluded because they failed to complete more than 70% of the Maze sentences.

Analysis The analysis of Experiment 7 was the same as that of Experiment 6.

Condition	Subject	Particle	Verb	NP1	NP2
BOUND NARROW	915.81 (23.08)	942.53 (18.30)	753.87 (17.63)	775.60 (11.27)	858.73 (15.45)
BOUND WIDE	871.99 (19.25)	920.40 (15.14)	744.59 (14.91)	869.60 (16.03)	887.51 (17.46)
FREE NARROW	902.01 (21.64)		760.55 (13.03)	753.31 (10.72)	838.76 (14.27)
FREE WIDE	864.24 (19.68)		793.01 (15.60)	808.03 (12.50)	832.59 (14.90)

Table 4.6: Experiment 7: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

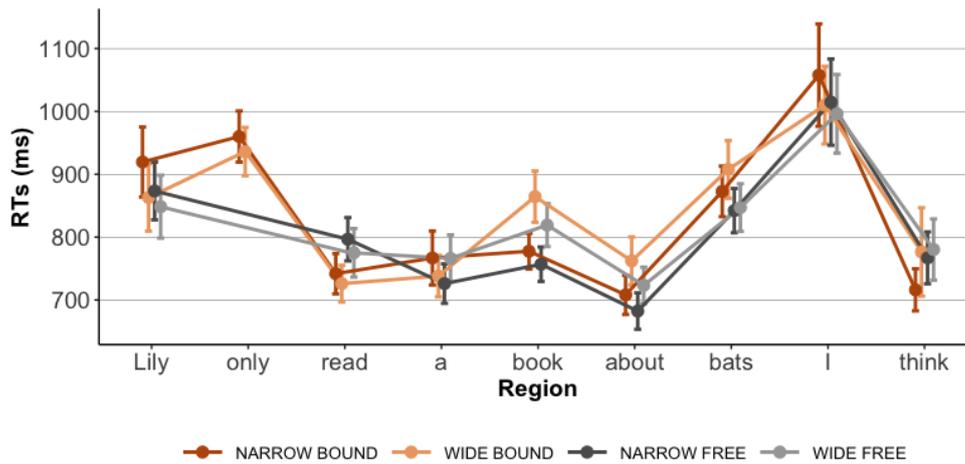


Figure 4.4: Experiment 7: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

4.5.2 Results

The mean comprehension question accuracy was 78%, and the mean completion rate of the maze target sentences of Experiment 7 was 87%. Mean response times for the target word and its surrounding regions in all conditions are given in Table 4.6. They are plotted with 95% confidence intervals in Figure 4.4.

Table 4.7 and 4.8 present the posterior estimates of the fixed effects as well as 95% credible intervals for both models of Experiment 7. Below, reliable effects on each region will be discussed. No reliable effects were found at the Subject and Verb region or at any of the Spillover regions.

		Estimate	Est.Error	95%CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
NP1	Intercept	2.88	0.01	[2.85, 2.91]	1.01	236	645
	Size	0.02	0.01	[0.01, 0.03]	1.00	8426	3352
	Type	0.04	0.01	[0.03, 0.05]	1.00	7562	3324
	Size:Type	0.01	0.01	[-0.01, 0.03]	1.00	6457	2932
NP2	Intercept	2.90	0.02	[2.87, 2.93]	1.01	351	756
	Size	0.01	0.01	[0.00, 0.03]	1.00	3645	3151
	Type	0.00	0.01	[-0.01, 0.01]	1.00	5491	3426
	Size:Type	0.02	0.01	[-0.01, 0.04]	1.00	5376	2885

Table 4.7: Posterior estimates for population-level effects of log RTs in Experiment 7, per region.

		Estimate	Est.Error	95%CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
NP1	Intercept	801.96	28.86	[744.58,857.69]	1.00	2346	4341
	Size	41.02	11.62	[17.99, 63.83]	1.00	24919	12270
	Type	74.12	12.68	[48.94, 98.99]	1.00	13454	11858
	Size:Type	38.54	23.81	[-8.32, 85.28]	1.00	25410	12823
NP2	Intercept	851.30	33.85	[784.67, 917.97]	1.00	579	1078
	Size	10.19	15.64	[-20.96, 41.04]	1.00	5674	3276
	Type	36.91	15.83	[5.48, 67.33]	1.00	3995	2679
	Size:Type	34.16	30.29	[-25.82, 93.80]	1.00	7171	3015

Table 4.8: Posterior estimates for population-level effects of untransformed RTs in Experiment 7, per region.

NP1 In the first NP (*book*), positive estimates for focus Size indicate that this noun was read faster in the wide conditions than the narrow conditions, and positive estimates for focus Type indicate that second occurrences of FREE foci were read faster than second occurrences of BOUND foci. The interaction between focus Size and focus Type was not reliable, however, and pairwise comparisons revealed that the effect of focus Size was reliable both among the BOUND conditions and the FREE conditions.

NP2 On the second NP (*bats*), positive estimates for focus Type again indicate that NP2 was read slower in the BOUND conditions than in the FREE conditions, but the estimates for focus Size, as well as the interaction effect, was not reliable.

4.5.3 Discussion

Experiment 7 replicated the second-occurrence focus slowdown by showing that reading times were longer on material that was part of a SO focus than on material that was not focus marked. However, such slowdowns were also present in the absence of a focus particle, i.e., on material that constituted the second-occurrence of a free focus. This may indicate that contextual contrasts affect reading behavior even when this process is not prompted by the presence of a focus particle—and, in fact, even when this material also was entirely given, entailed and did not provide the answer to a preceding question.

Again, the slowdowns observed on the second-occurrence of free foci may not in fact suggest that focus was also assigned to these phrases. But like in Experiment 6, the only difference between the NARROW and WIDE conditions was the size of the initially introduced alternatives. For instance, it may be that readers slow down more on NP1 in the WIDE conditions than in the NARROW conditions because they do not know yet which individual the subject of the target sentence (*Lily*) contrasts with. Crucially, though, the

relevant information for determining this is given on NP1 in the WIDE conditions and on NP2 in the NARROW conditions, because these are the phrases that are contrasted with each other in these conditions. To see this, note that both responses in (30b) and (30c) would be felicitous as a statement contrasting with (30a), but for (31) the two possible contrastive responses would be those in (31b) and (31c).

- (30) a. **Speaker A:** Abby read a book about penguins and whales, and Bob read a book about [bats]_F
- b. **Speaker B:** No, [Lily]_F read a book about bats
- c. **Speaker B:** No, [Lily]_F read a book about penguins
- (31) a. **Speaker A:** Abby read an article about penguins and a report on whales, and Bob read [a book about bats]_F
- b. **Speaker B:** No, [Lily]_F read a book about bats
- c. **Speaker B:** No, [Lily]_F read an article about penguins

In these FREE cases the left edge of each focus was thus also the left edge of material that determined which individual the subject was contrasted with, and it may therefore be that readers slowed down there because this material was less expected than material preceding it (e.g., the verb or the first NP in the NARROW conditions). However, such an account would also predict that, in the WIDE condition, slowdowns would disappear on the second NP, because this NP was fully predictable after the first NP was encountered. In that case, we would thus expect the NARROW FREE condition to yield longer reading times than the WIDE FREE condition on NP2. For now I will therefore set this possibility aside, though of course, it may be that the lack of such a NP2 slowdown is only a null effect.

In short, the NP1 slowdown in WIDE conditions (and the lack of an effect on the NP2 region) therefore suggests that comprehenders' representations of the contextually contrasted alternatives were maintained over longer stretches of discourse and affect reading behavior even after potential assignment of focus has taken place. Therefore, results from this experiment are consistent with an account of focus processing in which such contextually explicit contrasts generally cause comprehenders to encode what sets of alternatives are relevant in a discourse, even when computing the basic meaning of a sentence does not necessarily require comprehenders to activate a set of alternatives. This can be taken as evidence for the fact that alongside interpreting the meaning of individual clauses, comprehenders generally encode contextually salient sets of alternatives that are relevant for understanding the overarching structure of these discourses.

4.6 Conclusion

In short, this chapter investigated how a focus structure is assigned during their incremental interpretation of sentences. Experiment 5 showed that an underlying focus structure is assigned based on the presence of preceding questions that may put material in focus that was larger than a single word. Slowdowns in reading times were found even at the left edges of such wide foci, indicating that the source of these slowdowns cannot lie in the anticipation of a contrastive accent, which would only be assigned at the right edge of these foci.

Experiment 6 and Experiment 7 also investigated the processing of wide foci, and showed that focus can also be reliably assigned on contrastive foci, not just question/answer foci. Therefore, the anticipatory assignment of focus can even take place based on the presence of contrastive alternatives in the context alone. In fact, left-edge focus slowdowns

in Experiment 6 and Experiment 7 were found even on foci that were fully predictable from their context, suggesting that such slowdowns cannot solely be explained in terms of predictability of focused material either.

Together with findings from the previous chapter, this chapter showed that discourse comprehension generally involves the computation of contrastive alternatives. Chapter 3 showed that reading of unambiguously placed bound foci was facilitated when the preceding context also provided information about the type of alternatives that contrasted with the focus. The current chapter provides further evidence for the claim that alternatives are involved in the processing of focus by showing that contextually salient alternative expressions are used to determine what subsequent materials is put in focus. One possible way to therefore interpret the facilitative effect of alternatives in the preceding chapter is that in those cases too, the presence of alternatives in the context helped anticipate (the location of) the focus in the target sentence, allowing comprehenders to already carry out some of the computations necessary to interpret that focus in the presence of such contextual alternatives.

More generally, findings from Chapter 3 and 4 together suggest that the dependency between foci and their alternative sets can, in light of sufficient contextual evidence, be forward-looking in nature, such that contextual information about an alternative set can affect readers' behavior involving both the assignment and interpretation of downstream foci. The next chapter (Chapter 5) will show that the interpretation of foci is also backwards-looking, in the sense that comprehenders' representations of the context must sometimes be revisited during the interpretation of foci themselves. This chapter will further enrich the emerging picture of focus comprehension by investigating how the meaning of focus particles like *only* is computed during online sentence comprehension. It shows that the in-

terpretation of such particles crucially involves the re-activation of contextually mentioned contrastive alternatives, and that in this process, comprehenders rapidly incorporate pieces of information that are entailed by the preceding discourse context in order to determine which potential alternatives are contextually appropriate members of the alternative set.

Chapter 5

The role of context in the construction of an alternative set

5.1 Introduction

In the previous two chapters, I showed that contrastive alternatives are involved in the processing of focus in at least two ways. Chapter 3 showed that the explicit mention of contrastive alternatives in the context facilitates the reading of a subsequent focus, though these results did not specify where the facilitatory effect of mentioned alternatives stems from. Chapter 4 showed that one way in which explicitly mentioned alternatives may facilitate processing of a subsequent focus is that they allow comprehenders to disambiguate the placement of focus marking in sentences that are compatible with multiple focus structures. However, even in these cases the assignment of focus marking still caused slowdowns in reading, suggesting that the anticipation of foci does not altogether remove the cost induced by focus marking itself. I argued that these observations could be explained by a view of focus processing in which contextually-specified alternative sets may guide the assignment of subsequent foci in a forward-looking manner, but in which the interpretation of focus

itself still causes slowdowns due to the computation of alternative sets. This chapter further investigates what these computations may look like, and involves cases in which the processing of focus is instead solely *backward-looking*—i.e., cases in which the presence of a focus is overtly cued by a focus particle, but the preceding context does not allow for the anticipation of any particular focus structure. Because the inferences that must be derived from the presence of focus marking depend on such alternatives, these cases allow us to further test how the construction of an alternative set takes place during the comprehension of a focus.

This chapter builds on a growing body of research which has shown that the presence of focus intonation or focus particles leads to the (re-)activation of a focused expression's contrastive alternatives, using measures from reading, visual world, priming and memory tasks (Braun & Tagliapietra, 2010; Fraundorf, Watson, & Benjamin, 2010; Fraundorf, Benjamin, & Watson, 2013; Spalek, Gotzner, & Wartenburger, 2014; Kim, Gunlogson, Tanenhaus, & Runner, 2015; Gotzner, Wartenburger, & Spalek, 2016b; Braun, Asano, & Dehé, 2018; Yan & Calhoun, 2019; Hoeks, Toosarvandani, & Rysling, 2023). Although this work showed that conceptual, structural, and contextual information jointly restrict the relevant alternative set over time, the evidence across these different tasks has failed to converge on a unified understanding of the time-course of alternative set construction. Evidence from priming tasks suggests that while conceptual information shapes the constructed alternative set early on by activating semantic associates of the focused expression, structural information is only integrated at a later stage of processing (Husband & Ferreira, 2016). In addition to conceptual and structural information, evidence from memory tasks suggests that comprehenders also rely on information from the discourse context to differentially encode contextually plausible alternatives from implausible ones (Fraundorf et al., 2013),

while visual world studies have suggested that some types of contextual information may play a role early on in the processing of contrastive alternatives (Kim et al., 2015). Since these studies either used offline tasks or did not explicitly test the interaction between information from the discourse context and conceptual information, the way that linguistic contextual information affects the activation of alternatives over time has still not been studied independently from effects of general conceptual information or world knowledge. It is therefore still unclear what the mechanisms are through which comprehenders construct alternative sets in context, because it has not been shown how comprehenders' representation of the context can be accessed to construct the alternative set to a focus.

This chapter presents three reading studies, which aim to shed light on the time-course of alternative set construction as triggered by the presence of a focus particle. Their results indicate that the role linguistic contextual information plays in this process is entirely distinct from the role of conceptual information. In Experiment 8 and Experiment 10, longer reading times were observed on potential alternative expressions that were excluded from the alternative set by the preceding context than on contextually appropriate alternatives to a focus. In Experiment 8, these slowdowns were observed for alternatives that directly followed a focus and for alternatives that were not semantically associated to the preceding focus, suggesting that contextual information affected reading times (i) at an early stage of processing and (ii) independently of semantic association. Since slowdowns on contextually excluded alternatives were not observed in Experiment 9, in which a focus particle was absent, such slowdowns can therefore only be explained via a processing mechanism which re-accesses contextual information particularly in the interpretation of overtly signaled foci. Experiment 10—with a longer distance between the focus and the alternative—found slowdowns on contextually inappropriate alternatives that were both semantically associated

and non-associated to the preceding focus, suggesting that the effect of contextual exclusion among non-associated alternatives is maintained over time. Together, these studies show that linguistic contextual information is used rapidly in the activation of alternatives, at least as early as conceptual information—and that such early effects of linguistic context can, in fact, only be found among alternatives not conceptually related to a focus.

In Experiments 8-10, conceptual properties of potential alternatives were thus crossed with the contextual fit of these expressions as alternatives to a focus. All three experiments again used the Maze task to test how these properties affected the on-line construction of the alternative set. Following Lowder et al. (2021), who showed that readers utilize focus particles as cues to begin anticipating a set of upcoming sentence continuations, these experiments measured reading times on potential alternative expressions following a focus—thus probing to what extent processing of that focus may facilitate reading of subsequent alternatives while the comprehension of the sentence is still ongoing. In the next section, I will further motivate the design of these experiments by synthesizing the existing literature on alternative set construction.

5.2 Background on on-line alternative set construction

Under the most unrestrictive view on the nature of alternative sets (Rooth, 1985), the *contrastive alternatives* to a focus are all those linguistic expressions which could have coherently taken the place of that focus in a sentence (see Chapter 2 for more discussion on the characterization of alternative sets). But not all replaceable expressions may also come to mind as an alternative to a focus in all cases. For example, in a sentence like (1), although the expressions *steak* and *cookies* could both be substituted for it to form a grammatical sentence, comprehenders would generally not find *steak* to be a relevant

alternative, because steak is rarely eaten for dessert.

(1) For dessert, Sarah wanted only **cake**_F.

Some expressions may seem more natural or expected, and thus, more likely to be relevant alternatives than others. If one were asked out of the blue to name “things like cake,” one would more likely name *cookies* and other desserts or baked goods before one named *steak*. Under the permissive view on focus alternatives proposed by Rooth (1992a), alternative sets are therefore further restricted pragmatically, to include only those alternatives that are relevant in the particular context. How, in incremental interpretation, comprehenders actually impose such restrictions on the set of contrastive alternatives is still unclear, however.

In terms of cognitive mechanisms, one possibility is that comprehenders make use of general conceptual knowledge to activate concepts that are semantically associated with the expression in focus. But even though general conceptual relationships may be involved in comprehenders’ computations, they are not sufficient in constructing the alternative set because not all closely associated expressions can serve as an alternative to a focus. An expression like *pastry chef* may be closely associated to the word *cake* and is possibly also relevant to the broader scenario described by (1), but this expression does not contrast with the focus *cake*, exactly because we cannot substitute *pastry chef* for *cake* in this sentence. Under one proposed model of alternative set construction, structural information about the potential replaceability of an expression and conceptual information jointly factor into the construction of alternative sets (Husband & Ferreira, 2016; Gotzner et al., 2016b). After discussing evidence for this model in more detail below, I turn to evidence which suggests that information from the discourse context also plays an important role in the online construction of alternative sets. I then outline the open questions this evidence raises for this a

model of alternative set construction and that motivated Experiments 8-10.

5.2.1 The role of conceptual and structural information

Studies using cross-modal priming have demonstrated an effect of structural information on the activation of alternatives, establishing faster responses for viable contrastive alternatives, which can replace the expression in focus, than for mere semantic associates of a focus. Braun & Tagliapietra (2010) showed that a focus accent (on a word like *flamingo*) leads to facilitation of alternatives to the focused prime (e.g., words like *pelican*), when compared to expressions that were semantically associated with the focus but were not viable alternatives (like *pink*), because they were not substitutable expressions.

In later work, Husband & Ferreira (2016) probed the time-course of this alternative activation by manipulating the delay between presentation of the prime, in a sentence like (2), and a target.

(2) **Prime sentence:** The museum thrilled the **sculptor** when they called about his work.

Targets: painter (*contrastive*); statue (*non-contrastive*); register (*unrelated control*)

In conditions in which the prime received a focus accent, contrastive alternatives (*painter*) and non-alternative semantic associates (*statue*) were both found to be facilitated over unrelated controls when presented immediately following the prime. However, at a 750 ms delay after the focused prime offset, only contrastive alternatives were facilitated.

Husband & Ferreira (2016) took these findings as evidence for a two-stage model of alternative set construction in which semantic associates, first, become activated due to a general semantic priming mechanism, before the presence of focus intonation later leads

selection mechanisms to suppress activation of non-alternative associates (see Gotzner et al. (2016b) for a similar account). In this model, the alternative set is thus derived via a combination of general conceptual representations of lexical expressions and structural information about the focus, both syntactic and semantic, which determines what expressions can be felicitously substituted for it in the target sentence.

(3) **The ACTIVATION-SELECTION Model**

Contrastive alternatives to a focus become activated in two sequential steps:

- (i) When the meaning of the focused lexical material is retrieved, activation is spread to expressions that are conceptually associated with the expression in focus.
- (ii) Contrastive alternatives are selected for by suppressing activation of non-contrastive associates on the basis of structural information (semantic type or selectional restrictions of the focus' environment).

This model of alternative set construction is appealing because it relies on two mechanisms, both of which are known independently to be utilized in the comprehension of language (semantic associate priming and selection), and so the selection of contrastive alternatives parallels the way in which ambiguous words are disambiguated in context. When listeners encounter an ambiguous word such as *bug*, reaction time on lexical decision or naming tasks has been shown to be faster for words that were semantically associated with both meanings (*ant/spy*) compared to semantically unrelated words (*sew*), even when such words occur in a disambiguating sentence such as *The man was not surprised when he found several spiders, roaches, and other bugs...* (Conrad, 1974; Lucas, 1987; Onifer & Swinney, 1981; Seidenberg et al., 1982; Tanenhaus et al., 1979). Similarly to the facilita-

tion of non-contrastive associates, the facilitation of such inappropriate candidate meanings (*spy*) is also shown to be short lived: within as little as 200 ms, rejection of a sententially inappropriate meaning by a selection mechanism leads to deactivation of its associates while maintaining facilitation of a sententially appropriate meaning and its associates, regardless of whether the context was semantically or syntactically constraining (Tanenhaus et al., 1979).

However, this model implies that the use of structural information is contingent on the use of conceptual information, since an initially activated set of semantic associates is winnowed down at a later point using structural information about potential contrastive alternatives. It predicts that structurally licit alternatives cannot be selected from among non-associated expressions. In order to confirm this relationship between these types of information, language comprehenders' processing of contrastive alternatives that are *not* associated with the focused prime also have to be tested. Washburn et al. (2011) investigated the activation of such unassociated alternatives, arguing that semantically unrelated, but potentially replaceable expressions to a focused prime may also become activated, though only when such expressions are explicitly mentioned in the preceding context. This and related work, which I review next, establishes a role for the discourse context in the construction of alternative sets.

5.2.2 How discourse context may restrict alternative sets

In this section, I discuss evidence which suggests that the mechanisms through which comprehenders activate alternatives must also be sensitive to information from the preceding discourse context. This claim is in line with the conclusions of Chapter 4, where the contextual mention of contrastive alternatives allowed readers to assign focus marking. In

fact, I will argue that even when a focus itself cannot be anticipated ahead of time, the exact nature of its alternative set may still depend on the discourse that precedes that focus. Below, I identify three particular ways in which the plausibility of an alternative can be determined by context, without that context setting up a particular alternative set prior to the comprehension of the subsequent focus.

- (i) **Mention:** an expression is considered a relevant alternative because explicit mention in the preceding discourse makes it salient,
- (ii) **Situational availability:** while an expression may not have been mentioned, the specific properties of a situation, described in the preceding discourse, make it predictable based on world knowledge; or
- (iii) **Incidental exclusion:** even though it is mentioned, information in the preceding discourse may rule out an otherwise predictable expression as a plausible alternative.

Below, I first discuss evidence from the psycholinguistic literature for early effects of the first two types of contextual information on the activation of contrastive alternatives (mention and situational availability). These findings therefore do not fit clearly into the time-course of alternative set construction proposed by Husband & Ferreira (2016), as they suggest that contextual information may impact alternative set processing at an early stage, potentially as early as the effect of semantic association. I then discuss evidence that the third type of contextual information affects memory encoding of the potential alternatives involved (Fraundorf et al., 2013), suggesting that comprehenders are able to use discourse-specific information to rule out otherwise likely alternatives. Since this type of discourse information is entirely independent of conceptual or world-knowledge, it must be that, alongside structural information and general knowledge, comprehenders specifically

revisit their representations of the linguistic discourse context in activating alternatives to a focus. I therefore outline an extension of the ACTIVATION-SELECTION model proposed by Husband & Ferreira (2016), in which such discourse-specific information may be used to suppress activation on contextually excluded alternatives. Experiment 8 then tests the predictions of this EXTENDED ACTIVATION-SELECTION model.

5.2.2.1 Effects of explicit mention of alternatives

Washburn et al. (2011) showed that explicitly mentioned alternatives may become re-activated in the processing of focus. In a cross-modal priming task, they kept target (*locks*) constant across conditions, as shown in (4), while varying the nature of the prime sentences: the prime was either a contextually mentioned alternative that was semantically associated with the target (*bolt*), a contextually mentioned alternative that was non-associated with the target (*nails*), or an unmentioned control that was also not associated with the target (*lamp*).

(4) **Context:** Christina wants to buy a lock, nails, and a bolt. She needs these to fix her front entrance. Two days ago, she went to a store that didn't have a wide selection.

Prime sentence:

- a. At the store, she was able to buy (only) a **bolt**. Mentioned associated
- b. At the store, she was able to buy (only) **nails**. Mentioned non-associated
- c. At the store, she was able to buy (only) a **lamp**. Unmentioned non-associated

When a focus particle was present in the prime sentence, targets with a mentioned, non-associated prime (*nails*) were responded to faster than targets with an unmentioned, non-associated prime (*lamp*). This effect did not hold when the focus particle was absent, indi-

cating that expressions that are not associated with the focus may still become activated—presumably as contrastive alternatives to that focus—when these expressions are made salient by the discourse context.

Evidence from memory tasks converge on this conclusion, demonstrating increased competition from explicitly mentioned contrastive alternatives. Fraundorf et al. (2010) performed a truth verification task in which participants listened to discourses like (5a–b), and then were asked to accept or reject the truth of a statement involving either a previously mentioned focus (correct), a mentioned alternative (incorrect), or an unmentioned one (incorrect), as shown in (5c–e).

- (5) a. **Context:** Both the British and the French biologists had been searching Malaysia and Indonesia for the endangered monkeys.
- b. **Exposure sentence:** Finally, the **British** spotted one of the monkeys in Malaysia and planted a radio tag on it.

Truth verification target:

- c. The British scientists found the endangered monkey. Focus
- d. The French scientists found the endangered monkey. Mentioned alternative
- e. The Portuguese scientists found the endangered monkey. Unmentioned alternative

Presence of a focus accent on the target in the exposure sentence (*British*) was found to enhance discrimination between the correct statement and the mentioned alternative lure, but it did not reliably improve discrimination between the correct and the unmentioned alternative lure, suggesting that focus prosody may lead participants to more deeply encode

mentioned alternatives but not unmentioned ones. Fraundorf et al. (2013) also replicated this finding using font emphasis to cue the presence of focus accent in silent reading.

Together, these findings suggest that context must also play a role in the (re)activation of focus alternatives—and that contextually salient, but non-associated alternatives become re-activated as early as the semantic associates in Husband & Ferreira (2016). The targets in Washburn et al. were presented 250 ms after the prime offset, indicating that merely mentioned alternatives are also part of an early cohort of activated expressions. Below, we discuss additional evidence suggesting that contextually mentioned alternatives in fact allow comprehenders to start reasoning about the alternative set even before the focus is encountered.

In a visual world study by Kim et al. (2015), listeners heard a target sentence containing a focus in a context, as in (6). Fixations began to converge earlier on the focused target (*apples*) when it was mentioned in the preceding context.

(6) **Context:**

- | | |
|--|-------------|
| a. Neil has some apples and some cards | Mentioned |
| b. Neil has some lanterns and some cards | Unmentioned |

Target sentence: Jane (*only*) has some **apples**.

This effect was not observed when *only* was absent in the target sentence. In the conditions that explicitly mentioned the target, fixations began to converge on that target approximately 200 ms after word onset, before the point in time when fixations could reflect a change due to auditory information from the target word itself. This suggests that when foci are interpreted in rich enough contexts, comprehenders already start reasoning about the alternative

set even before the focus is encountered.

Earlier results from a self-paced reading paradigm by Sedivy (2002), discussed in Chapter 4 also support the conclusion that contextual contrasts help anticipate a focus. In this study, the presence or absence of contrastive alternatives in a context sentence affected parsing decisions in temporarily ambiguous sentences, suggesting that readers anticipated the relevant set of alternatives to a focus based on information in the discourse context.

Both Kim et al.'s (2015) and Sedivy's (2002) studies suggest that the time-course of alternative set processing is heavily impacted by the presence of explicitly mentioned alternatives, but mechanistically there may be multiple different ways in which such early effects of contextual mentioned alternatives may come about. As Fraundorf et al. (2013, p. 203) point out, one hypothesis is that the set of alternatives that becomes activated includes any salient expression in the discourse belonging to the same superordinate category as the focus itself. For instance, if the expression *apple* is focused, any contextually salient term referring to a fruit may become re-activated as a relevant alternative. Alternatively, it may also be that the alternative set is constrained, not just by contextual salience, but also by more fine-grained properties of the discourse context, which guide comprehenders to consider expressions compatible with the particular scenario being described. Next, I discuss evidence which shows that in addition to the presence of explicitly mentioned expressions in the discourse, the specific properties of a situation that are described in the preceding discourse, can also make an expression predictable based on world knowledge. More broadly, this evidence therefore suggests that comprehenders do not just activate salient expressions, but instead rely both on the particular state of affairs in an individual discourse and general world-knowledge (e.g., as incorporated in a *situation model* as in Zwaan & Radvansky (1998)). Again, this information can be used to anticipate a set of alternatives, suggesting

that even such situation-specific contextual information is used early during the time-course of alternative set processing.

5.2.2.2 Effects of situational availability

Kim et al. (2015) demonstrated the role of a focus particle like *only* in narrowing down likely upcoming material. In another visual-world study, they showed that fixations converged on the target earlier in biasing contexts which described scenarios compatible with a narrow set of alternatives, like (7a-b), than in contexts compatible with a wider range of alternatives, like (7c-d)—even when the target itself wasn't explicitly mentioned.

(7) **Context:**

- a. Neil and Alex are at the baseball game. Alex wants to buy some hot dogs and some nachos. Biasing, Mention
- b. Neil and Alex are at the baseball game. Alex wants to buy some Coke and some nachos. Biasing, No Mention
- c. Neil and Alex are at the supermarket. Alex wants to buy some hot dogs and some cherries. Neutral, Mention
- d. Neil and Alex are at the supermarket. Alex wants to buy some bell peppers and some cherries. Neutral, No Mention

Target sentence: Neil (only) wants to buy some hot dogs

Importantly, this effect was found both when a focus particle was present and when it was absent in the target sentences. This suggests that besides explicitly mentioned alternatives themselves, category information influences expectations about upcoming discourse across

the board, rather than specifically when required by particles like *only*, though such information can guide listeners' expectations about upcoming focus alternatives as well. For instance, the context in (7a) indicates that the subsequent target sentence should be interpreted in the setting of a baseball game, and general world-knowledge may in that case make *hot dogs* a salient alternative despite it being unmentioned. Kim et al. (2015) therefore propose that comprehenders generate hypotheses about the contextually relevant set of focus alternatives—enabling them to more rapidly converge on an appropriate visual target in biasing contexts.

Lowder et al.'s (2021) eye movement data further support the general conclusion that focus particles allow alternatives to be anticipated based on world knowledge. They found that the presence of a focusing construction (*not only the bride...*) eliminated predictability effects on a subsequent alternative, such that only in the absence of this focus particle unpredictable nouns (*...but also the priest*) were read more slowly than predictable nouns (*..but also the groom*). Together with the results from Kim et al. (2015), this may suggest that comprehenders exploit such focus-sensitive particles to anticipate a set of possible alternatives that are compatible with the scenario at hand, and thus that situation-specific information may play a role even before the focus is encountered.

Again, the exact mechanisms underlying these early effects of situation-specific information is not entirely clear. In Kim et al.'s (2015) materials, the biasing context sentences included expressions (e.g., *baseball game*) that were arguably more closely related to the target (*hot dogs*) than material in the non-biasing contexts (*supermarket*). Even though the target itself was not mentioned in the No Mention conditions, there may still be a role for semantic priming in explaining these effects because it is possible that material in the Biasing contexts generally primed the targets, and that this information is then utilized in the

construction of the alternative set. Below, I discuss evidence of effects of discourse-specific information on the activation of alternatives that cannot be attributed to semantic priming or general predictability based on world knowledge.

5.2.2.3 Effects of discourse-specific information

Fraundorf et al. (2013) tested the hypothesis that the set of alternatives that become activated in the processing of focus is additionally constrained by incidental discourse-specific information which rules out expressions as plausible alternatives to a focus, building on independent findings that this type of information can restrict the interpretation of referring expressions that are in principle ambiguous (Brown-Schmidt & Tanenhaus, 2008). Perhaps in establishing which alternatives are relevant for the interpretation of foci, too, it is the case that expressions that are described in the discourse as implausible or unlikely are not treated as relevant alternatives, despite them being overtly mentioned and generally compatible with the type of situation described in the context. Fraundorf et al. (2013) constructed stimuli in which a preceding linguistic context manipulated whether mentioned expressions were either plausible or implausible alternatives to a focus. An example of such a context sentence is given in (8), where Saturn, Neptune and Jupiter are all mentioned exactly once in the discourse but in the target sentence only Saturn is a plausible alternative to Jupiter.

- (8) a. **Context:** Originally, the space probe Cosmo III was designed to fly past *Jupiter* and *Saturn* and send photos and measurements back to NASA from both planets. NASA needed this information to guide the videos they were going to take of *Neptune* on a future mission.
- b. **Target:** However, due to a glitch in the programming of the Cosmo III, it lost the photos taken of **Jupiter** and put the future mission in trouble.

This is because, although Neptune is also mentioned and may be predictable in this context, it is a poor alternative to Jupiter in this particular discourse because it establishes that the mission to Neptune has not yet occurred and photos of Neptune could therefore not have been lost instead.

In their truth verification task, Fraundorf et al. (2013) indeed found that font emphasis helped reject false statements about plausible alternatives (*Saturn*), but not about less plausible alternatives that were nevertheless mentioned in the discourse (*Neptune*). Note that the contextual information manipulated in this experiment—in which contexts always involved the same amount of overt material—crucially differed from that in Kim et al. (2015)—in which the contextual bias was manipulated by including specific lexical items. Because the identity of the plausible and implausible alternatives was counterbalanced by Fraundorf et al. (2013), participants could not have relied on their lexical, conceptual or world-knowledge in ruling out alternatives here. These results therefore more clearly suggest that readers encode a narrow set of only those alternatives plausible in the particular discourse, independently of whether these alternatives were salient, available via world-knowledge or conceptually associated to any other overtly provided material in the context.

However, since this was an offline memory study, it does not provide evidence about the time-course over which these alternatives are ruled out from the alternative set. It is therefore more generally unclear how comprehenders integrate such incidental, discourse-specific information with conceptual or world-knowledge in constructing the relevant set of alternatives. Next, I turn to a hypothesis about how this process plays out, and how it can be tested.

5.2.3 Testing the role of discourse context in alternative set construction

Husband & Ferreira (2016) propose a modal of alternative set processing, in which contrastive alternatives become activated during the processing of a focus, first by spreading activation from the expression in focus to semantically associated expressions, and then by selecting contrastive alternatives from among the initially activated cohort of semantic associates. Although this ACTIVATION-SELECTION model makes a number of testable predictions for the way alternatives become activated in out-of-the-blue contexts, it does not specify how contextual information would be integrated in the activation of contrastive alternatives. The evidence discussed above indicates that the overt mention of alternatives in the context as well as situation-specific information affects the activation of alternatives at least as early as effects of semantic association, and that more incidental properties of the linguistic context affect alternative set processing independently from general conceptual knowledge—though the time-course at which this latter type of information plays a role is less clear. To test how contextual information is integrated with conceptual and structural information in the time-course of alternative set processing, the most straightforward path, in the first instance, would be to simply extend the Activation-Selection model, so it incorporates information from the discourse context.

The most conservative way to do this, based on the evidence discussed above, would be for overtly mentioned alternatives to be among the initially activated set of expressions, alongside expressions that become primed based on conceptual information and world-knowledge, and that both structural properties of the focus and the incidental exclusion of alternatives by the discourse context subsequently leads to the inhibition of expressions that are either structurally illicit or implausible alternatives to the focus. This model is summarized in (9).

(9) **The EXTENDED ACTIVATION-SELECTION Model**

Contrastive alternatives to a focus become activated in two sequential steps:

- (i) When the meaning of the focused lexical material is retrieved, activation is spread to expressions that are conceptually associated with the expression in focus, and contextually salient expressions are activated as well.
- (ii) Contrastive and contextually relevant alternatives are selected for by suppressing activation of non-contrastive and/or non-relevant associates on the basis of structural (semantic type or selectional restrictions of the focus' environment) and discourse-specific information (contextual plausibility).

This EXTENDED ACTIVATION-SELECTION model makes two predictions, which Experiment 8 was designed to test. First, because selection takes place only after activation is spread to semantic associates, it predicts effects of contextual exclusion to show up only at a late stage of processing. Experiment 8, as well as the subsequent experiments, thus made use of on-line reading measures to test when discourse-specific information that rules out salient and otherwise plausible alternatives comes into play in the process of alternative set activation. Second, because contextually appropriate alternatives would be selected from among previously activated semantic associates under this hypothesis, it predicts that discourse-specific information only affects those alternatives that become activated due to them being semantically associated to the focus. Experiment 8 therefore crossed semantic association with the contextual appropriateness of an alternative to test if and when non-associated alternatives are also affected by contextual information during focus comprehension.

5.3 Experiment 8

Experiment 8 investigated whether, at an early stage of focus processing, comprehenders rely on information from the linguistic discourse context in addition to semantic association to construct a set of contextually relevant alternatives. It used online reading measures to probe the time-course of comprehenders' sensitivity to these two types of information—in particular, how semantic association and contextual exclusion of an expression jointly affect the integration of that expression as an alternative to a preceding focus.

Similar to Lowder et al. (2021), a focus construction was used in which a potential alternative expression always directly followed a focus (e.g., *Lily bought only apples, but no pears*), which enabled an expression's ease of integration, as an alternative to the focus, to be measured by the time it takes to read that expression. If semantic associates become activated in the processing of a focus, then a potential alternative that is semantically associated to the focus (as in *...apples, but no pears*) should be integrated faster and/or more reliably than a potential alternative that are non-associated (as in *...only forks, but no pears*). All else being equal, this difference in activation between associated and non-associated alternatives should show up as a difference in reading times on the alternative that directly follows the focus. However, if readers also initially activate alternatives based on world-knowledge-independent contextual information, non-associated alternatives may sometimes be integrated more easily than associated alternatives—for instance, when they are more suitable as alternatives in a particular discourse context. Such a pattern of results would suggest that comprehenders rely on discourse-specific information that incidentally rules out alternatives already during the initial activation of the alternative set, instead of using such contextual information to select contextually-appropriate alternatives from among conceptual associates at a later stage, as is suggested by the Extended Activation-Selection

model.

5.3.1 Method

Materials In Experiment 8, every item constituted a short narrative in which a short context sentence first introduced three contextual alternatives. In all conditions, a target sentence then put one of these explicitly mentioned alternatives in focus using the focus particle *only*, contrasting this *focused alternative* with a second *target alternative*, previously mentioned in the context.

The shape of the context and target sentences was kept constant across conditions. In the target sentence, only the focused alternative varied, manipulating semantic Association of the target alternative with the focus (assoc vs non-assoc), as illustrated in (10).

- (10) a. When the waiter returned, he remembered to bring only *milk* but no **cheese** to the table where the tourist was seated. ASSOC
- b. When the waiter returned, he remembered to bring only an *ashtray* but no **cheese** to the table where the tourist was seated. NON-ASSOC

Although the identity of the focused alternative (in italics) varied, the target alternative (in bold) and its surrounding regions remained constant across conditions, thus allowing for a direct comparison between RTs on this alternative as preceded by an associated (*milk*) or non-associated (*ashtray*) focus. Association was determined throughout using Latent Semantic Analysis (Landauer et al., 1998), where the average similarity of alternatives and foci was 0.58 (range: 0.4 - 0.86) in the assoc conditions, and 0.09 (range: 0.18 - 0.07) in the non-assoc conditions. See Appendix B for a list of all such alternative triplets.

The identity of the alternatives in each context manipulated contextual Exclusion, that

is, whether the target alternative was explicitly excluded as an alternative to the focus (excl) or not (non-excl). In the non-excl conditions, the target alternative was always mentioned in the first context sentence, which set it up as a plausible alternative to the focus; in the excl conditions, the target alternative was always mentioned in the second context sentence, which ruled it out as a potential alternative to the focus. For each condition in the example item set below, the context was different (11a–d), while the target sentence varied between Associated (11a–b) and Not Associated (11c–d) conditions.

(11) **Context:**

- a. The tourist asked for a variety of items, like some cheese and milk.
There was already an ashtray on the table. ASSOC NON-EXCL
- b. The tourist asked for a variety of items, like an ashtray and milk.
There was already some cheese on the table. ASSOC EXCL
- c. The tourist asked for a variety of items, like some cheese and an ashtray.
There was already some milk on the table. NON-ASSOC NON-EXCL
- d. The tourist asked for a variety of items, like an ashtray and milk.
There was already some cheese on the table. NON-ASSOC EXCL

Target: When the waiter returned, he remembered to bring only {*milk*_(a-b) | an *ash-tray*_(c-d) } but no **cheese** to the table where the tourist was seated.

Contextual Exclusion of the target alternative was achieved by ensuring that the presuppositions of the predicate inside the target sentence were satisfied for the first two contextual alternatives but not for the third contextual alternative. In (11), the target sentence’s predicate *remember to bring* presupposes, roughly, that whatever its object refers to was being

asked for. Since the second sentence in each context entails that this item was already on the table, it is unlikely that it was asked for by the tourist, implying that it is not among the things that the waiter should have remembered to bring. Thus, the item mentioned in the second context sentence is always an unlikely alternative to the focus, because the target sentence contrasted items that the waiter remembered to bring with items that the waiter did not remember to bring.

Note that this contextual manipulation made the target sentences the EXCL conditions incoherent with the preceding discourse context. It is therefore unsurprising that slowdowns could be observed on the target alternative, because this is the point in the target sentence where this incoherence with preceding discourse may first become apparent. But note that this type of infelicity is not a confound of the present design, because the goal of the subsequent experiments is to show that readers are in fact only sensitive to such infelicities when a focus particle precedes the target alternative. Experiment 9 will therefore use the same materials as Experiment 8 but will not include the particle in order to show that discourse contextual information only influences reading of the target alternative when focus is overtly signaled.

In total, 48 items were constructed, each with the four conditions as illustrated in (10). All items for Experiment 8 can be found in Appendix I. These experimental items were interspersed with 64 fillers which also consisted of multi-line discourses and included both foci in the target sentence and focus alternatives in the preceding context. Using a Latin Square design, all 48 items were counterbalanced over 4 lists, such that each participant saw one condition from every item.

Procedure All target sentences were presented using the Maze task, which measures response times using button presses. In this task, participants advance through a sentence by

choosing at each word which of two items is the correct continuation of that sentence. Each word in the target sentence was thus presented alongside a distractor word (or *foil*) which would not make a sensical continuation. An example of one target item is given in (12) below, with the foil presented below the corresponding intended word of the target sentence. For more details of this task see the Method section of Experiment 1 in Chapter 3.

- (12) When the waiter returned, he remembered to bring only milk but no cheese
x-x-x arm behave greatest, am democratic on rates ago gone, went or surely
to the table where the tourist was seated.
all pun apply widen been would over makes.

In this way, sentences were presented incrementally, and the response time required to make and execute a decision about which word should continue a sentence was measured.

Importantly, this task was chosen in particular because it encourages highly incremental processing, but also because it provides a measure of the level to which upcoming structure is anticipated: Maze response times have been shown to be inversely related to noun cloze probabilities, with slower responders showing larger effects of expectation (Husband, 2022). This property is particularly useful here because response times on target alternatives can thus in part be taken to index to what extent these expressions are expected as alternatives to the preceding focus.

Maze foils were automatically generated using the AutoMaze software developed by Boyce, Futrell, and Levy (2020), and manually checked to prevent frequent use of the same foil throughout the materials (for details on this algorithm, see again Chapter 3).

On every trial, participants first read a context sentence on one screen. On a subsequent screen, participants were presented with the start of the target sentence in the format of the Maze task. That is, only the target sentence was presented incrementally; the context sentences were presented all at once for normal reading. Half of the experimental trials were

followed by a comprehension question, which probed whether participants had read the context preceding the target sentence. For instance, the example item in (11) was followed by the comprehension question in (13).

(13) What was already on the table where the tourist was seated?

Before being presented with the target stimuli and fillers, participants read a short description of the task, followed by five practice items. Practice items were similar to experimental items in that they involved a short context sentence, followed by a sentence presented in Maze format and a comprehension question. After the short practice phase, the experimental items were presented along with the fillers in a pseudo-random order.

Participants 53 participants were recruited via the Prolific platform for web-based research and were paid a \$12 hourly rate for their participation. All participants were native speakers of English and gave explicit consent to participate. Participants who had an accuracy of less than 80% on the comprehension questions or that did not complete more than 70% of the Maze sentences were excluded from analysis. Data from 48 participants were included in the analysis; 5 participants were excluded because they failed to complete more than 70% of the Maze sentences.

Analysis Data were analyzed using R, version 3.6.3 (R Core Team, 2021). We fit Bayesian (generalized) linear mixed-effect models using Stan, as implemented in the brms package, version 2.18.0 (Bürkner, 2017), with the default priors. Separate models were fit to log-transformed response times and untransformed response times as dependent measures. For each model, we ran four chains, each with 5000 steps (warmup = 1000 steps). Rhat statistics in all models approached 1.00 and no warnings emerged. Models included fixed effects

Condition	Previous -1	Previous	Critical region	Spillover	Spillover +1
assoc excl	825.21 (17.63)	815.59 (20.29)	1043.29 (23.44)	1094.64 (27.98)	940.34 (20.54)
non-assoc non-excl	833.16 (15.62)	834.47 (19.34)	1044.98 (19.35)	1080.60 (24.87)	951.40 (26.73)
non-assoc excl	858.30 (29.79)	810.29 (18.71)	1135.21 (24.83)	1116.18 (29.47)	907.00 (23.26)
assoc non-excl	811.71 (15.12)	795.18 (16.24)	989.21 (21.01)	1076.63 (22.95)	903.42 (21.11)

Table 5.1: Experiment 8: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

of semantic Association and contextual Exclusion (deviation-coded), with associated and non-excluded conditions treated as reference levels, and random slopes and intercepts for both subjects and items (Baayen et al., 2008).

Posterior model estimates will be considered reliable if their 95% credible interval does not overlap with zero. Pairwise comparisons between conditions were carried out using the hypothesis function, with a Bonferroni-style adjustment for the size of the credible intervals.

5.3.2 Results

The mean comprehension question accuracy for Experiment 8 was 85%, and the mean completion rate of the maze target sentences was 87%.

Mean response times for the target word and its surrounding regions in all conditions are given in Table 5.1. They are plotted with 95% confidence intervals in Figure 5.1.

Tables 5.2 and 5.3 present the posterior estimates obtained in the models of Experiment 8 log-transformed response times and untransformed response times on target words, respectively. Only one main effect was reliable in both models: positive estimates of Association indicate that semantically associated target alternatives were responded to faster than target alternatives that were not semantically associated with the focus. The credible interval for contextual Exclusion did not include zero in the model on raw RTs, but it overlapped with zero for the model run on log RTs, so this main effect will not be considered

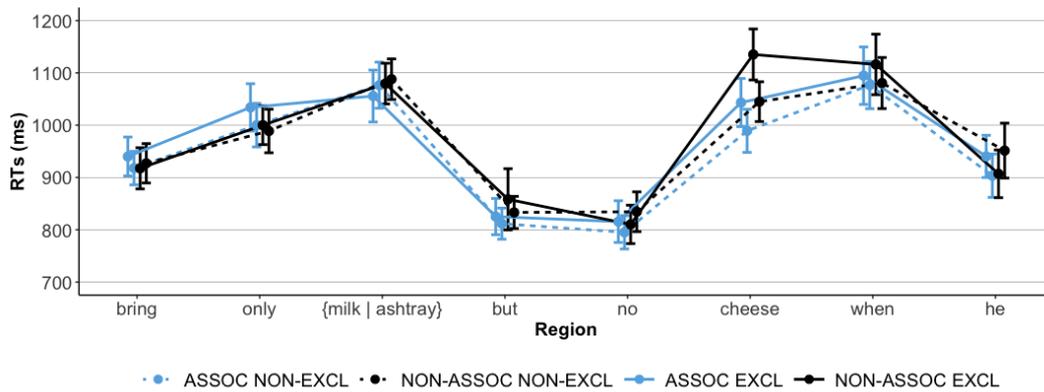


Figure 5.1: Experiment 8: mean RT in each region per condition. Error bars represent 95% confidence intervals.

	Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	2.9839	0.0139	[2.97,3.01]	1.00	2608	5371
Association	0.0293	0.0081	[0.01,0.05]	1.00	20317	13678
Exclusion	0.0212	0.0119	[-0.00,0.05]	1.00	13131	12086
Assoc: Excl	0.0062	0.0128	[-0.02,0.03]	1.00	29194	12627

Table 5.2: Posterior model estimates for the population-level effects of Bayesian mixed effects model on logRTs of Experiment 8.

	Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	1045.66	37.83	[972.36, 1119.26]	1.00	3844	6672
Association	72.06	22.75	[26.77, 116.97]	1.00	19712	12240
Exclusion	71.45	34.52	[4.09, 139.72]	1.00	13968	12775
Assoc:Excl	30.06	40.78	[-49.70, 109.98]	1.00	32259	13081

Table 5.3: Posterior model estimates for the population-level effects of Bayesian mixed effects model on untransformed RTs of Experiment 8.

reliable here. However, pairwise comparisons revealed that non-associated excluded target alternatives were responded to more slowly than non-associated non-excluded targets, for both log-transformed ($\beta = 0.025$; 97.5% Cr.I=[0.0006,0.05]) and untransformed response times ($\beta = 86.92$; 97.5% Cr.I=[9.29, 165.15]). The credible interval for the difference between associated excluded and associated non-excluded again overlapped with zero, for both log-transformed ($\beta = 0.016$; 97.5% Cr.I=[0.013, -0.01]) and untransformed response times ($\beta = -56.90$; 97.5% Cr.I=[-135.66,24.27]).

5.3.3 Discussion

In Experiment 8, target alternatives that were semantically associated with the focus were read faster than non-associated target alternatives. More importantly, expressions that were contextually excluded from the alternative set of a focus were read more slowly than expressions that were not excluded as alternatives, though this effect of contextual exclusion was only reliable for alternatives that were not semantically associated to the preceding focus. This contextual Exclusion effect was observed while processing of the target sentence was still ongoing, and only a couple words after the focus was encountered.

These findings are in line with previous studies that showed early effects of explicit mention in the linguistic context and situation-specific information (Washburn et al., 2011; Kim et al., 2015; Sedivy, 2002). However, in Experiment 8, alternatives were explicitly mentioned in the preceding context in all conditions, so the differences in response times among alternatives cannot be attributed to their relative salience alone, unlike the results from previous studies showing an early effect of explicit mention. The observed slowdowns on contextually excluded non-associated alternatives can only be explained if the incorporation of contextual information about the members of the alternative set does not depend on semantic association, because distinguishing contextually appropriate non-associated alternatives from inappropriate ones could not be accomplished by relying on lexical or conceptual knowledge. The fact that an effect of contextual Exclusion was observed while both salience of the relevant target alternative and the relation between the focus and the target alternative were held constant suggests that comprehenders form expectations about which expressions make up the alternative set to a focus based on information that is specific to the discourse: for the example items in (11), this information tells us what objects are in which location. The effect of contextual Exclusion observed in Experiment 8 cannot

be explained in terms of a contextual priming mechanism, like the one proposed by Kim et al. (2015), where the focus and the discourse context jointly prime alternative expressions. Such an account, in which activation would spread from a focus to conceptually related expressions as specified by the context, would have to be augmented to incorporate more incidental discourse information which is crucially independent from any general conceptual or world-knowledge.

If the contextual exclusion effect observed in Experiment 1 can be attributed to the processing of focus, then these results would suggest a less conservative extension of the Activation-Selection model, in which contextual restriction of the alternative set takes place based on representations of the context itself, and not *just* by virtue of these alternatives being salient or activated via comprehenders' general conceptual or world-knowledge. They would be consistent, for instance, with a scenario in which early on in the processing of a focus, comprehenders revisit previously encoded representations of the linguistic context to generate a set of expressions that can serve as focus alternatives within that specific context.

We investigate this alternative hypothesis with Experiment 10. First, we address a potential independent concern about the data in Experiment 8: As it stands, the contextual exclusion effect observed here could simply be due to properties of the preceding discourse that make the subsequent mention of contextually Excluded alternatives generally less natural or less predictable. Experiment 9 was therefore designed to test what the role of focus marking is in the contextual exclusion effect.

5.4 Experiment 9

To establish that reading time differences on the target alternatives in Experiment 8 arose specifically due to the processing of the preceding focus, no expression was put in

focus with a focus particle in the target sentences of Experiment 9. Experiment 9 tests whether the contextual Exclusion effect observed in Experiment 8 is still observed when the focus particle is removed. If RT differences there were, at least in part, due to activation of alternatives in the processing of focus, then those effects should be diminished or entirely disappear in the absence of a focus particle which signals the presence of focus marking.

5.4.1 Method

Materials The materials of Experiment 9 were identical to the materials of Experiment 8, except that the focus particle *only* was removed from all target sentences, as in the example item set in (14).

(14) **Context:**

- a. The tourist asked for a variety of items, like some cheese and milk.

There was already an ashtray on the table. ASSOC NON-EXCL

- b. The tourist asked for a variety of items, like an ashtray and milk.

There was already some cheese on the table. ASSOC EXCL

- c. The tourist asked for a variety of items, like some cheese and an ashtray.

There was already some milk on the table. NON-ASSOC NON-EXCL

- d. The tourist asked for a variety of items, like an ashtray and milk.

There was already some cheese on the table. NON-ASSOC EXCL

Target: When the waiter returned, he remembered to bring { *milk*_(a-b) | an *ashtray*_(a-b) } but no **cheese** to the table where the tourist was seated.

Condition	Previous -1	Previous	Critical region	Spillover	Spillover +1
assoc non-excl	756.73 (16.80)	790.03 (18.48)	923.73 (19.45)	998.89 (26.47)	877.35 (24.56)
assoc excl	786.03 (20.04)	767.34 (15.82)	964.194 (22.65)	980.84 (22.49)	871.04 (21.38)
non-assoc non-excl	760.74 (19.57)	770.96 (17.44)	964.81 (21.22)	972.63 (20.47)	870.06 (25.06)
non-assoc excl	728.71 (13.59)	759.92 (18.00)	021.58 (25.82)	987.24 (24.16)	893.05 (29.69)

Table 5.4: Experiment 9: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

Participants 51 participants were recruited via the Prolific platform for web-based research and were paid a \$12 hourly rate for their participation. All participants were native speakers of English and gave explicit consent to participate. Participants who had an accuracy of less than 80% on the comprehension questions or that did not complete more than 70% of the Maze sentences were excluded from analysis. Data from 46 participants were included in the analysis; 5 participants were excluded because they failed to complete more than 70% of the Maze sentences.

Procedure The procedure was the same as that of Experiment 8.

Analysis The data analysis was analogous to that of Experiment 8, with models including fixed effects of semantic Association and contextual Exclusion (deviation-coded), and with associated and non-excluded conditions treated as reference levels.

5.4.2 Results

The mean comprehension question accuracy was 79%, and the mean completion rate of the maze target sentences of Experiment 9 was 89%. Mean response times for the target word and its surrounding regions in all conditions are given in Table 5.4. They are plotted with 95% confidence intervals in Figure 5.2.

Tables 5.5 and 5.6 present the posterior model estimates results for the log-transformed response times and untransformed response times on target words of Experiment 9, respec-

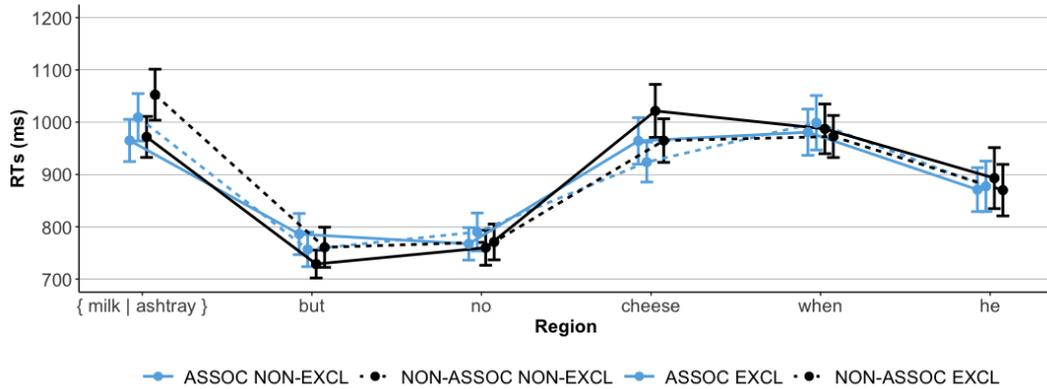


Figure 5.2: Experiment 9: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

tively. Both models found only one reliable main effect: positive estimates of Association indicate that semantically associated target alternatives were responded to faster than target alternatives that were not semantically associated with the focus. Pairwise comparisons revealed no reliable differences between the non-associated excluded target alternatives and the non-associated non-excluded targets, for both log-transformed ($\beta = 0.004$; 97.5% Cr.I.=[-0.027, 0.020]) and untransformed ($\beta = 6.92$; 97.5% Cr.I.=[-71.5, 58.15]) response times. Again, for both log-transformed ($\beta = -0.01$; 97.5% Cr.I.=[-0.03, 0.01]) and untransformed ($\beta = 26.05$; 97.5% Cr.I.=[-91, 38]) response times, no reliable difference were detected between associated excluded targets and associated non-excluded ones.

	Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	2.96	0.02	[2.93,2.99]	1.00	1885	3622
Association	0.018	0.008	[0.0031,0.0335]	1.00	20834	13083
Exclusion	0.01	0.01	[-0.01,0.03]	1.00	13448	12696
Assoc: Excl	-0.01	0.01	[-0.03,0.02]	1.00	23686	13001

Table 5.5: Experiment 9: Model estimates for the population-level effects of Bayesian mixed effects model on logRTs.

	Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	968.70	42.85	[885.09,1053.15]	1.00	3093	5632
Association	52.55	25.87	[1.56, 103.11]	1.00	12874	12736
Exclusion	45.80	24.42	[-2.54, 93.37]	1.00	22168	11982
Assoc:Excl	10.77	42.44	[-72.67, 94.98]	1.00	23996	12582

Table 5.6: Model estimates for the population-level effects of Bayesian mixed effects model on raw RTs of Experiment 9.

5.4.3 Discussion

The effect of contextual Exclusion found in Experiment 8 was not observed in Experiment 9. Experiment 8 showed that readers rapidly integrate discourse-specific information which rules out expressions as alternatives to the focus, causing slowdowns on such contextually excluded alternatives. But readers were not sensitive to this type of information in Experiment 9, in which a focus particle was absent from target sentences. This indicates that the effect of contextual Exclusion observed on alternatives in Experiment 8 was indeed arose as a consequence of the processing of the bound focus that preceded them.

These findings are in line with those reported by Lowder et al. (2021), who showed that readers exploit the presence of a focus sensitive particle as a cue to the location of a focus; this, in turn, allows them to rapidly compute which set of expressions contrast with that focus, affecting reading times on subsequent alternatives. Together with the findings from Experiment 8, they are also consistent with studies which suggest more generally that, in the presence of a focus particle, contextual information is integrated more quickly in alternative set processing (Washburn et al., 2011; Kim et al., 2015; Sedivy, 2002).

Since the contextual exclusion effect observed in Experiment 8 only arose in the processing of a focus, those results falsify both predictions of the extended Activation-Selection model: contextually appropriate alternatives cannot only be selected from among previously activated semantic associates. It must be the case that comprehenders use and revisit the

representations of the context they have encoded (as in a situation model), independently of semantic association, to generate hypotheses about expressions that can serve as focus alternatives in a specific context. The expressions that can serve as alternatives can be accessed directly via representations of the context, not solely through world-knowledge or the conceptual relationships that exist between expressions in the lexicon.

This does not require abandoning a role for semantic association altogether: it may very well be that alternatives become activated simultaneously by spreading activation from a focus to semantically associated expressions and by accessing representations of the linguistic context. Empirically, semantically associated alternatives were found to be facilitated over non-associated ones in both Experiment 8 and Experiment 9. As Husband & Ferreira (2016) suggest, it seems reasonable to assume that semantic association plays a very general role, giving rise to facilitative effect even in the absence of focus marking. In fact, they argue (p. 229) that comprehenders may take different strategies to activate alternatives in different scenarios. Perhaps in the absence of a context that provides enough information about the nature of the alternative set, comprehenders may rely more on the way their general conceptual knowledge is organized; when foci are interpreted in rich enough contexts, alternatives may also become activated based on contextual information alone, as is suggested by the present data.

We should consider the possibility then that these two processes—automatic spreading of activation and reactivation of the contextual information—in fact happen in tandem. Such a model would not only straightforwardly account for the fact that comprehenders' strategies for activating alternatives may depend on their available information, but it would also correctly predict that, at an early stage of processing, expressions that are generally associated to the focus become activated alongside contextually appropriate, non-associated

alternatives.

A model which combines a general spreading activation mechanism with a distinct contextual reactivation mechanism would also make predictions for later stages of processing. For instance, despite the independent role of contextual information, activation on automatically activated associates that are structurally illicit or contextually inappropriate must still be suppressed—as is also the case in an Activation-Selection model. Both scenarios would predict a late difference in RTs among those associated alternatives that are contextually appropriate and those that are contextually inappropriate. The crucial difference between the two models, however, is that if conceptual and contextual information are dealt with by distinct mechanisms, late effects of context should be present among non-associated alternatives, too, while the effects of semantic association should fade away as time passes. If, on the other hand, contextual information is only used to *select* alternatives from among semantic associates, the effect of semantic association should be maintained over time, while a difference should start to emerge between those associated alternatives that are contextually appropriate and those that are not. Experiment 10 was designed to test how semantic Association and contextual Exclusion interact at a later stage of processing.

5.5 Experiment 10

Like Experiment 8, Experiment 10 crossed Association between the focus and the target alternative with contextual Exclusion of those target alternatives. But unlike Experiment 8, it measured response times on alternatives with a larger distance between those alternatives and the preceding focus, allowing more time between the initial computation of the focus alternatives as triggered by *only* and the later explicit mention of these potential alternatives and their integration into the target sentence. If activation of semantically

associated alternatives is only short-lived while the effect of contextual Exclusion persists over time, as is suggested above, then Experiment 10 should only show an effect of contextual Exclusion because the target alternative occurs in a position in which the effect of semantic Association should already have subsided. If, on the other hand, contextually relevant alternatives are selected from among initially activated semantic associates, an effect of semantic Association should persist over time.

5.5.1 Method

Experiment 10 makes use of the same context sentences as those used in Experiment 8 and Experiment 9, but the target sentences in Experiment 10 were constructed such that the distance between the focus and the target alternative inside the target sentences was longer than those in Experiment 8.

Materials Materials of Experiment 10 were identical to the materials of Experiment 8, except that the target sentence now contained a longer distance between the focus and the target alternative. An example of an target item of Experiment 10 is given in (15).

(15) **Context:**

- a. The tourist asked for a variety of items, like some cheese and milk.
There was already an ashtray on the table. ASSOC NON-EXCL
- b. The tourist asked for a variety of items, like an ashtray and milk.
There was already some cheese on the table. ASSOC EXCL
- c. The tourist asked for a variety of items, like some cheese and an ashtray.
There was already some milk on the table. NON-ASSOC NON-EXCL
- d. The tourist asked for a variety of items, like an ashtray and milk.

There was already some cheese on the table.

NON-ASSOC EXCL

Target: When the waiter returned, he remembered to bring { milk_(a-b) | an ashtray_(c-d) } but he forgot to bring any **cheese** to the table where the tourist was seated.

Participants 48 participants were recruited via the Prolific platform for web-based research and were paid a \$12 hourly rate for their participation. All participants were native speakers of English and gave explicit consent to participate. Data from 48 all participants were included in the analysis, and all participants had an accuracy of at least 80% on the comprehension questions and completed at least 70% of the Maze sentences.

Procedure The procedure was the same as that of Experiment 8 and Experiment 9.

Analysis The data analysis was analogous to that of Experiment 8 and Experiment 9, with models including fixed effects of semantic Association and contextual Exclusion (deviation-coded), and with associated and non-excluded conditions treated as reference levels.

5.5.2 Results

Mean response times for the target word and its surrounding regions in all conditions are given in Table 5.7. They are plotted with 95% confidence intervals in Figure 5.3. The mean comprehension question accuracy was 85%, and the mean completion rate of the maze target sentences of Experiment 10 was 89%.

Tables 5.8 and 5.9 present the fixed effects results for the models of Experiment 10 log-transformed response times and untransformed response times on target words, respectively. Both models found only one reliable main effect: positive estimates of Exclusion indicate that contextually Excluded target alternatives were responded to slower than target

Condition	Previous -1	Previous	Critical region	Spillover	Spillover +1
assoc ex	825.21 (17.63)	815.59 (20.29)	1043.29 (23.44)	1094.64 (27.98)	940.34 (20.54)
non-assoc non-ex	833.16 (15.62)	834.47 (19.34)	1044.98 (19.35)	1080.60 (24.87)	951.40 (26.73)
non-assoc ex	858.30 (29.79)	810.29 (18.71)	1135.21 (24.83)	1116.18 (29.47)	907.00 (23.26)
assoc non-ex	811.71 (15.12)	795.18 (16.24)	989.21 (21.01)	1076.63 (22.95)	903.42 (21.11)

Table 5.7: Experiment 10: mean RT and standard error of the mean in each condition two words before, at, and two words after the target word.

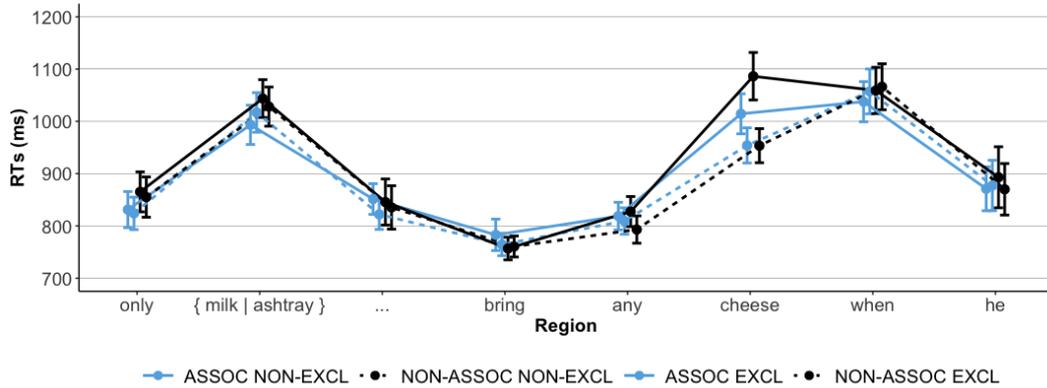


Figure 5.3: Experiment 10: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

alternatives that were not contextually excluded. The main effect of Association was not reliable, but pairwise comparisons revealed that the difference between the non-associated excluded target alternatives and the associated excluded targets was reliable, for both log-transformed ($\beta = -0.027$; 99% Cr.I=[-0.044,-0.010]) and untransformed ($\beta = 73.95$; 99% Cr.I=[9.61,135.04]) response times. Moreover, as in Experiment 8, the difference between the non-associated excluded condition and the non-associated non-excluded conditions was again reliable in both log-transformed ($\beta = 0.045$; 99% Cr.I=[0.025,0.064]) and untransformed ($\beta = 128.55$; 99% Cr.I=[51.16, 204.17]) response times.

5.5.3 Discussion

In Experiment 10, RTs on contextually excluded alternatives were longer than those on alternatives that were not contextually excluded. In addition, the effect of semantic As-

	Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	2.9716	0.0118	[2.949,2.995]	1.0014	2669	5699
Association	0.0137	0.0070	[-0.000,0.028]	0.9999	16456	13290
Exclusion	0.0316	0.0082	[0.016,0.048]	1.0002	15100	12584
Assoc: Excl	0.0256	0.0142	[-0.002,0.053]	1.0000	18225	12794

Table 5.8: Posterior estimates for the population-level effects of Bayesian mixed effects model on logRTs of Experiment 10.

	Estimate	Est.Error	95% CrI	Rhat	Bulk _{ESS}	Tail _{ESS}
(Intercept)	998.89	29.23	[941.16,1056.09]	1.00	4530	7110
Association	36.32	20.16	[-3.30, 75.62]	1.00	18114	13634
Exclusion	91.86	24.41	[44.58, 139.94]	1.00	13002	12370
Assoc:Excl	74.69	39.08	[-0.35, 151.03]	1.00	21506	11841

Table 5.9: Posterior estimates for the population-level effects of Bayesian mixed effects model on raw RTs of Experiment 10.

sociation between the preceding focus and the target alternative was reliable, but crucially only among alternatives that were contextually excluded: response times on contextually excluded alternatives that were not closely associated with the focus were read even more slowly than associated but excluded alternatives.

The main difference with the pattern of results obtained in Experiment 8 is that in Experiment 10 the effect of contextual Exclusion was also reliable among the conditions with semantically associated target alternatives. This effect is consistent both with an Activation-Selection model, in which contextually appropriate alternatives are selected from among semantic associates, and with one in which semantic association and contextual information are dealt with by distinct mechanisms. In either scenario, contextual support for appropriate alternatives should facilitate reading of semantic associates at this stage of processing.

However, the overall response time pattern in Experiment 10 is consistent only with a model in which contextual information and semantic association are dealt with separately, for two reasons.

First, as in Experiment 8, the slowdown on contextually excluded non-associated alter-

natives, in particular relative to non-associated non-excluded ones, can only be explained if contextual knowledge about the salient expressions that can serve as contextually appropriate alternatives is encoded and directly re-accessed in the processing of that focus, independently from the use of conceptual information. If alternatives are only selected from among initially primed semantic associates, this particular effect would not be expected because such a selection mechanism would only *suppress* activation on contextually inappropriate associates instead of *increasing* activation on non-associated but contextually appropriate alternatives.

Second, there was no facilitatory effect of associated contextually appropriate alternatives over non-associated ones in Experiment 10, not even a numerical one, despite Experiment 8 showing a trend for such an effect. For contextually appropriate alternatives, any potential facilitation of associates over non-associates thus entirely disappeared as the distance between the focus and the target alternatives increased. This finding is only in line with a multiple-mechanism model, and not with an Activation-Selection model: if contextual exclusion could only affect RTs via a selection mechanism that suppresses activation of contextually inappropriate semantic associates, then semantically associated alternatives should generally be facilitated over semantically non-associated ones. Again, this is because while activation of contextually appropriate associates would be maintained over time, non-associated alternatives would never become activated in the first place, even if they were contextually appropriate.

5.6 Conclusion

Three reading studies tested the nature and the time-course of the information comprehenders utilize in activating contrastive alternatives in the processing of a focus-marked

phrase. In Experiment 8 and Experiment 10, target sentences explicitly mentioned an alternative following an expression which was put into focus by the focus particle *only*, in order to test how the processing of that focus affects reading of a later alternative. Preceding contexts always mentioned such alternatives, and moreover manipulated whether they were either contextually appropriate as alternatives to the focus or not.

Results of Experiment 8 and Experiment 10 showed slowdowns on expressions that were contextually specified as inappropriate alternatives to the preceding focus, suggesting that contextual information can guide comprehenders in ruling out alternatives as part of the relevant alternative set, despite their being both salient and closely semantically associated with the focus. Results of Experiment 8 in particular showed that this type of contextual information can be taken into account on material in close proximity to the focus itself. Results of Experiment 9 verified that these effects of contextual exclusion were due to the processing of the focus, as they disappeared in the absence of a focus particle.

More specifically, I contrasted two hypotheses about the way in which comprehenders may use such contextual information to activate contextually appropriate alternatives. On the one hand, it may be that contextual information is used to select alternatives from an initially activated set of semantic associates, as described in (16), which conservatively extends the model proposed by Husband & Ferreira (2016).

(16) **The EXTENDED ACTIVATION-SELECTION Model**

Contrastive alternatives to a focus become activated in two sequential steps:

- (i) When the meaning of the focused lexical material is retrieved, activation is spread to expressions that are conceptually associated with the expression in focus, and contextually salient expressions are activated as well.

- (ii) Contrastive and contextually relevant alternatives are selected for by suppressing activation of non-contrastive and/or non-relevant associates on the basis of structural (semantic type or selectional restrictions of the focus' environment) and discourse-specific information (contextual plausibility).

Alternatively, it may be that instead of first automatically activating a large cohort of salient expressions and selecting plausible alternatives from among them, contextual information about plausibility may also affect the alternative-activation process in a more immediate way, for instance because comprehenders re-activate their representations of the semantic discourse context directly and generate expectations about plausible alternatives based on such representations. This hypothesis, which is summarized in (17), suggests that there are two simultaneous ways in which alternatives to a focus may become activated: via general conceptual relationships between expressions, or via comprehenders' semantic representations of the specific discourse context.

(17) **The ACTIVATION+GENERATION Hypothesis:**

Contrastive alternatives to a focus can become activated via two simultaneous mechanisms:

- (a) Contrastive alternatives can become activated by spreading activation to semantically associated expressions and later suppressing activation on inappropriate associates; or
- (b) Contrastive alternatives can be directly generated by revisiting representations of the discourse context that specify which alternatives contrast with the focus.

The ACTIVATION+GENERATION Hypothesis was motivated by the results from Experiments 8-10, which were only partially in line with the EXTENDED ACTIVATION-SELECTION Model. Although they suggested that early activation of associates may temporarily override finer-grained context-specific preferences—semantically associated but contextually excluded alternatives were facilitated alongside contextually appropriate alternatives in Experiment 8—they also suggest that such context-specific preferences can help facilitate non-associated but contextually appropriate alternatives—both in early (Experiment 8) and later stages of focus processing (Experiment 10). This suggested that, at least when foci are interpreted in rich enough contexts, like the ones tested here, comprehenders do not only rely on conceptual relationships between expressions. They are also able to directly exclude alternatives via the information provided by those discourse contexts themselves, as in the ACTIVATION+GENERATION Hypothesis. Under this hypothesis, alternatives may be generated based on comprehenders' representations of the discourse context, which correctly predicts that effects of contextual exclusion were found even for alternatives that are not associated with the focus, in both Experiment 8 and Experiment 10.

These findings also have consequences for the view of focus outlined in Chapter 2. Results from these experiments suggest that even when the exact nature of the alternative set of a focus is not explicitly signalled ahead of time, information from the discourse context can still be used to construct the set of contextually relevant alternatives after the focus is encountered. This means that such discourse-specific information must be encoded upon initial processing, that these representations are maintained over time, and that they can be accessed during the processing of the focus (particle).

One way of fleshing this out in more mechanistic terms would be to adopt a model of discourse comprehension like Zwaan & Radvansky (1998), in which discourse under-

standing involves not only the representation of a textbase (i.e., some representation of the linguistic surface structures), but also the activation, encoding, and updating of a *situation model* in episodic memory (i.e., the cognitive representation of the events, actions, individuals and states a discourse is about). One assumption of this model is that efficient comprehension in discourse is possible because knowledge is used strategically: what information is accessed depends on the goals of the language user, the amount of available information from the context, the level of processing, and the degree of coherence needed for comprehension. To use this knowledge strategically, language users try to establish coherence relationships among the pieces of linguistic structure that make up a discourse.

Adopting such a model of discourse processing would help with interpreting the pattern of results observed here, too. Since focus marking serves to indicate a relevant contrast between the focused marked expression and its (implicit) set of alternatives, it might be strategic to try to interpret the focus as contrasting with a set of expressions that are provided within the preceding discourse itself. The presence of a focus particle in particular may cue an upcoming focus as well as an upcoming contrast, and may thus trigger comprehenders to access information stored as part of the situation model in order to resolve such potential coherence relationships. In the processing of a focus, comprehenders would then be able to access parts of this situation model in order to re-activate those alternative expressions that are contextually appropriate as alternatives to the focus, giving rise to both early (Experiment 8) and late facilitation of contextually appropriate alternatives (Experiment 10), as well as memory benefits (Fraundorf et al., 2013). In short, as is already suggested by Fraundorf et al. (2013), focus processing may constitute a discourse comprehension process in which both general knowledge and discourse-specific information can be strategically used to construct an alternative set.

As I discussed above, the re-activation of such contextual information may take place independently from a more general-purpose, automatic spreading of activation to expressions that are conceptually related to the focused expression. Indeed, this general priming mechanism may have driven the effects in the previous studies—which only tested semantically associated alternatives (and did not include non-associated alternatives in their designs)—as well as some of the data presented here. However, since semantic association was fully crossed with contextual appropriateness of an alternative in the present studies, a better picture of the way in which semantic association and contextual information interact was obtained in the current experiments. They indicated that, although both semantic associates and contextually appropriate alternatives become activated in the comprehension of a focus (and both types of expressions are therefore facilitated in lexical decision, truth verification, memory or reading tasks), the activation of alternative expressions does not *depend* on the activation of semantic associates. Instead, they suggested that focus alternatives are also activated via a mechanism that accesses discourse-specific information directly.

Together with Chapter 3 and 4, the broader picture that emerges from these findings is one where, on the one hand, the comprehension of focus generally involves the construction of contextually-specified alternative sets, while on the other, this process itself may take substantially different shapes depending on the type of contextual information comprehenders have at their disposal. In Chapter 3, discourse contexts allowed comprehenders to encode such alternative sets before the focus was encountered, while in this chapter contextual representations were revisited to construct the alternative set, and this process was only triggered by the focus particle that cued the upcoming focus. In both cases, the representations that comprehenders dealt with were abstract, in the sense that they pertained to information not just related to linguistic surface forms. Since the foci in Chapter 3 were

larger than a single word, the encoding of alternative sets could not simply have involved lexical representations of alternatives. Similarly, in the present chapter showed that the mental representations that comprehenders used to reason about the contextual restriction of alternative sets could not have been lexical either, because in these experiments the potential alternative expressions were ruled by the discourse context despite the fact that they were explicitly mentioned. Instead, the right level of representation at which reasoning about such alternatives takes place must thus make reference to abstract semantic information, because it is only based on what is entailed by the common ground that readers could have determined whether an expression was excluded from the alternative set in this case.

When comparing the findings from Chapter 4 and 5, one prominent question that remains is what properties of the discourse context determine whether expressions are merely mentioned as opposed to giving rise to the encoding of an alternative set prior to the comprehension of the focus. It is easy to see that mention itself is not enough for comprehenders to also consider a set of expressions as contrastive: In the experiments of Chapter 4, mention alone was not sufficient to set up an alternative set, because the narrow alternatives in the NARROW conditions were in fact contained within the wider alternatives in the WIDE conditions. Therefore, such narrow alternatives were always mentioned in all the WIDE NP conditions even though focus was assigned to wider phrases in these conditions. It could be that this is because, more generally, only the largest contrasts provided in a context are relevant for the assignment of focus. This principle could also explain the fact that mentioned alternatives weren't anticipatorily encoded as the relevant contrasts in the present experiments, because larger pieces of discourse were instead more relevantly contrasted with each other in these contexts. I address this possibility in more detail in the final chapter (Chapter 6), in which I conclude this dissertation and outline some avenues for future work.

Chapter 6

Conclusion

I started out this dissertation with the assumption that the comprehension of language is incremental and involves the construction of abstract representations—a process which I assumed to be guided both by linguistic-specific knowledge and domain-general information and mechanisms. This dissertation then asked, for focus in particular, to what extent its comprehension involves the incremental construction of such representations as well. In order to address this question, the experiments reported in this dissertation studied the time-course of focus processing using reading measures. These experiments were designed to test the following hypotheses:

Hypothesis 1. The time-course of focus processing: Comprehenders complete the processes necessary to interpret a focus as soon as the relevant information becomes available.

Hypothesis 2. Representations of focus processing: Alongside the basic structure and meaning of an utterance, comprehenders also construct representations of focus structure and of the evoked alternative set.

Results of these experiments indeed showed that the processing of focus is both more incremental and involves representations that are more abstract than previously thought.

Before summarizing these results in more detail, recall that in Chapter 2 I made one more analytical step: I argued that the processing of focus could be better understood by viewing it as a complex process that consists of several subprocesses which are both interdependent and dependent on external information.

(1) **The subprocesses of focus comprehension**

- ① Assignment of focus
- ② Constructing the alternative set
- ③ Establishing a dependency with context
- ④ Incorporating alternatives into sentence meaning

I used this division into subprocesses specifically to bridge insights from theoretical semantics about the interpretation of foci with the behavioral evidence on focus processing. This division also allowed us to gain traction on the question of why the processing of focus as a whole may unfold over time differently in different contexts: I argued that the reason for this is that each of these subprocesses depends, in their own way, on both linguistic-specific information available in the context and domain-general knowledge and mechanisms. Next I summarize how the experimental results supported this claim.

6.1 Summary of the main findings

6.1.1 Chapter 3

Chapter 3 reported four reading studies in which readers progressed through a sentence in the Maze task (Forster et al., 2009), deciding at each word between a sensical and a non-sensical continuation. These experiments aimed, first, to disentangle effect of given-

ness from effects of focus. In Experiment 1, contexts presented before these sentences manipulated whether words were linguistically focused and whether they were given or new. Focused targets were read more slowly even when they were given, and new targets were read slowly in general. This both replicated earlier results in which slowdowns were found in the reading of focus (Benatar & Clifton, 2014; Birch & Rayner, 1997; Lowder & Gordon, 2015), and demonstrated that focus slowdowns are not reducible to newness.

To clarify earlier results in which speed-ups were found on focused words (Birch & Rayner, 2010; Morris & Folk, 1998), contexts in Experiments 2 and 3 manipulated whether contrastive alternatives to focused words were presented with a focus particle (Experiment 2) or in a cleft construction (Experiment 3). Focused targets were read less slowly when a contrastive alternative was present in the context. Results thus showed that the processing of focus is modulated both by givenness and by the presence of contrastive alternatives in the context, thereby clarifying the inconsistencies in the reading literature on focus in which these factors were manipulated in various different ways.

Finally, this effect of contrastive alternatives could not be reduced to simple semantic associate priming of these alternatives: In Experiment 4, contexts also manipulated whether a semantically associated expression was present independently of the presence of a contrastive alternative. In this experiment, readers slowed down less when an alternative was present in the context, even when this alternative was not semantically associated to the target.

Together, these findings indicated that a comprehensive theory of the processing of focus must incorporate the concept of contrastive alternatives, as well as an explanation for their systematic interactions with newness (Experiment 1), different focus constructions (Experiments 2 and 3), and semantic association (Experiment 4). I outlined an account of

focus processing in which the observed slowdowns on foci are due, at least in part, to the fact that the comprehension of foci depends on such contrastive alternatives. These results also motivated Chapters 4 and 5, which further investigate in what way alternatives are involved in the processing of focus.

6.1.2 Chapter 4

In most of the studies which showed that focus marking has important ramifications for various aspects of language processing, the devices used to signal the presence of a focus (accents, clefts, particles) did so unambiguously. However, language users are often also confronted with structures that are ambiguous with respect to the size and location of the focus they contain. The way in which comprehenders assign a focus structure to a sentence in such cases has received considerably less attention. In Chapter 3, I therefore investigated the process of focus assignment in silent reading and I argue that we can better understand *why* foci are processed differently from non-focused material when we also know *how* comprehenders decide which material is focused marked in the first place.

In three additional reading studies, I showed that the assignment of a focus structure is more than the prediction of a focal accent, because effects of focus were found even on material that did not receive a pitch accent (Experiment 5). Moreover, I showed that the assignment of focus cannot be equated to the anticipation of new or unpredictable information that provides the answer to a preceding question either, again because focus slowdowns were observed even in the absence of explicit preceding questions and when focused material was fully predictable given the preceding context (Experiment 6 and Experiment 7). These two experiments investigated the reading profile of second occurrence foci—i.e., foci that are fully predictable from their context and whose corresponding alternatives and infer-

ences do not need to be computed anew. Results from these experiments showed that focus marking still caused slowdowns on such foci. Because the manipulation of alternatives in the context affected the assignment of focus in these cases, these results suggest that focus comprehension involves tracking what alternative sets are relevant in a given discourse, irrespective of the predictability of these alternatives themselves.

I therefore concluded, (i) that the incremental assignment of focus in silent reading is mediated by comprehenders' representations of alternative sets. But more broadly, I also took these results to indicate (ii) that although the assignment of a focus structure and the computation of its corresponding alternative set itself is a highly context-dependent process, once a focus structure has been assigned the differential allocation of resources to the processing of foci takes place even for foci that are fully predictable in their context. This suggests that the role of focus in sentence processing is not just to allow comprehenders to allocate resources to the interpretation of unpredictable information, but instead is a more complex process which involves the structuring of information in discourse more generally.

6.1.3 Chapter 5

Finally, Chapter 5 further investigated how comprehenders use context to compute which alternatives appropriately contrast with a focus. This chapter built on a growing body of research that showed that the presence of focus prosody and/or a focus particle leads to activation of contrastive alternatives (Braun & Tagliapietra, 2010; Fraundorf et al., 2010, 2013; Spalek et al., 2014; Husband & Ferreira, 2016; Gotzner et al., 2016b; Braun et al., 2018; Yan & Calhoun, 2019; Hoeks et al., 2023). In particular, it has been argued in this literature that comprehenders rely on general conceptual knowledge to first activate a large cohort of expressions by spreading activation from the the focus to semanti-

cally associated expressions, and only later distinguish contrastive, replaceable associates from non-contrastive associates (Braun & Tagliapietra, 2010; Husband & Ferreira, 2016; Gotzner et al., 2016a). Other studies have shown that contextual information also plays an important role in the activation of alternatives, for instance by showing that contextually plausible alternatives are better remembered than implausible ones (Fraundorf et al., 2013). Evidence across these different tasks has failed to converge on a unified understanding of the time-course of the activation of alternatives, however, because the way that linguistic contextual information affects the activation of alternatives over time has not been studied independently from effects of conceptual information or world knowledge. In this chapter I therefore tested how such general knowledge and contextual information jointly affect the activation of alternatives over time.

In three more reading studies using the Maze task, response times were measured on expressions that were potential alternatives to a preceding focus. Context sentences further manipulated whether those expressions were associated with the focus and whether or not they were explicitly excluded from the alternative set of the focus. In Experiment 8, information about the contextual exclusion of an alternative was used independently of information about the conceptual relationships between focus and potential alternatives, because slowdowns on contextually excluded alternatives were found even among non-associated alternatives. These effects of contextual exclusion were observed for alternatives that directly followed a focus and for alternatives in Experiment 8, further suggesting that contextual information affected reading times at an early stage of processing. Since slowdowns on contextually excluded alternatives were not observed in Experiment 9 in which a focus particle was absent, such slowdowns can therefore only be explained via a processing mechanism which utilizes linguistic discourse information particularly in the activation

of focus alternatives. Experiment 10—with a longer distance between the focus and the alternative—found slowdowns on contextually excluded alternatives that were both semantically associated and non-associated to the preceding focus, suggesting that the effect of contextual exclusion among non-associated alternatives is also maintained over time.

In line with the results from Chapter 3 and 4, I therefore concluded that besides conceptual information about similarity or associative relationships between expressions, comprehenders also make use of more fine-grained aspects of the discourse context in the processing of focus. Alongside general conceptual knowledge, contextually-appropriate expressions can be selected as members of the relevant alternative set from representations of the discourse context directly, and at early stages of alternative set processing. When foci are interpreted in rich enough contexts, comprehenders thus actively rely on abstract linguistic information (similar to those adopted in formal semantics) in establishing what the relevant alternatives to a focused phrase are. These findings again underscore the fact that the processing of focus involves abstract representations that are continuously updated based on incoming information—in this case contextual information about how the set of possible alternatives is restricted to include only those alternatives that are plausible as alternatives in the given context.

6.1.4 Takeaways

Together, these chapters show that the relevant contextual information that comprehenders use in completing ①-③ is abstract, because it is inferred from semantic information provided in the discourse that is interpreted off of larger pieces of linguistic structure, not just from lexical or conceptual representations that comprehenders may generally have access to. Although results from Chapter 3 showed that explicitly mentioned contrastive

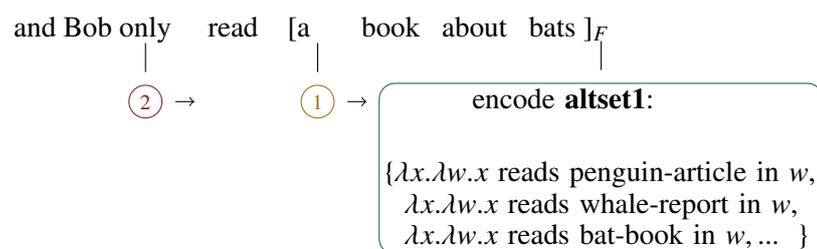
alternatives facilitated the comprehension of a downstream focus, Chapters 4 and 5 also showed that mention of such alternatives alone is not sufficient to trigger the encoding of an alternative set. At the very least, some notion of semantic contrast beyond mention of individual linguistic expressions is necessary to explain the way focus was assigned and comprehended in these cases.

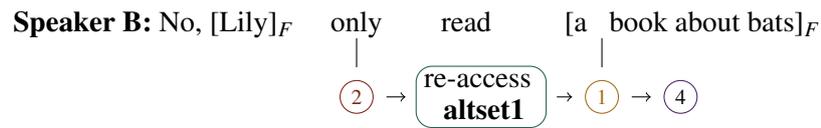
These findings suggest that the relevant type of information that allows comprehenders to incrementally and predictively complete these processes is information about *contrast*. And it suggests, moreover, that the type of abstract representations that are posited are representations involving such contrasts. This is the crucial finding that allows us to refine the two hypotheses posited in the outset of this dissertation. I thus make the following claim about the time-course and representations involved in focus processing.

Claim 1. Time-course and Representations of focus processing: Comprehenders are able to complete the processes in ①-③ incrementally and predictively because, alongside the basic meaning and structure of an utterance, they encode, maintain and update representations of the contrasts that structure the information given in a discourse.

To illustrate what I mean with this, consider again the WIDE SOF conditions in Experiment 6 of Chapter 4, repeated in (2) below.

(2) **Speaker A:** Abby read an article about penguins and a report on whales,





Recall that in these discourses, slowdowns were observed at the left edge of the second-occurrence focus in Speaker B’s utterance. The above view of focus in which information about contrasts can be encoded and maintained can account for this: In this case, it is the contrast between various types of reading materials signaled within Speaker A’s utterance triggers the construction of an alternative set and the corresponding assignment of focus marking within that utterance ((2) → (1) → (3)). The encoded alternative set can then be re-accessed and used to again assign focus to the same material.

In other words, I argue that representations of the alternative set are revisited when focus marking needs to be assigned to a sentence, and are encoded or updated during the construction of the alternative set. I thus argue that it is this constellation of processes that ultimately causes the slowdowns observed on foci throughout this dissertation—not the fact that such foci may be generally new, unpredictable or otherwise communicatively important.

6.2 Beyond alternative-based approaches to focus semantics

This dissertation argued that alternatives play a crucial role in focus comprehension, but of course there are also theories of focus which derive their meaning in ways that are not alternative-based. Below, I will outline two such theories and I will discuss how the current data may speak to them.

Under the Structured Meaning approach to focus (von Stechow, 1982, 1991; Jacobs, 1983; Krifka, 1992) the meaning of a focused sentence is an ordered pair (background, focus), such that the background when applied to the focus denotation yields the ordinary

interpretation. Under this approach, the placement of focus determines what the focus and the background of the sentence are, but no reference has to be made to focus alternatives. In contrast, the representation of a *background* is not part of Alternative Semantics, and these types of theories could therefore make different predictions regarding the mental representations that are entertained during the incremental interpretation of language. For instance, a Structured Meanings approach may suggest that the relevant mental representations in the processing of focus would involve representations of focus-background structures, not necessarily alternative sets.

Although the experiments presented here do not have a definitive answer to the question of whether the representation of a background is indeed part of the mental representations involved, what their data does suggest is that comprehenders seem to be sensitive to fine-grained properties of the alternative set. In Experiments 8-10, comprehenders were able to distinguish contextually appropriate alternatives from inappropriate ones at an early stage only in the presence of a focus particle, suggesting that the computations triggered by these particles are at least in part responsible for these behavioral effects. Without making explicit reference to alternatives, these findings would be more difficult to explain because it would be less clear what the connection would be between the comprehension of a focus particle and the slowdowns on subsequent alternatives (or rather, the lack of such slowdowns in the absence of a focus particle). Of course, the explanatory link between focus particles and the exclusion/inclusion of alternative expressions may still come from somewhere else, but at least a ⟨background, focus⟩ structure alone would not predict comprehenders to reason about individual members of the alternative set like they seem to be doing in Experiments 8-10. Future work, described in more detail below, could further test the extent to which alternatives themselves are computed by investigating whether compre-

henders are also sensitive to even more fine-grained properties of alternative sets such as structural properties of alternatives or their potential exhaustivity. Again, a simple distinction between focus and background would not predict such sensitivity.

This would apply similarly to theories which define focus solely in terms of newness/ givenness, as in Schwarzschild (1999): If the mental representations of focus only involve a distinction between new and given material, slowdowns on particular alternative expressions—like those found in Experiments 8-10— would not be predicted unless such slowdowns instead stem from a mechanism that is not specific to focus. Schwarzschild's (1999) particular theory of focus and givenness would also have trouble explaining the slowdowns on given foci as in Experiment 1 and Experiments 5-7, because in these cases the relevant foci were interpreted in light of salient discourse antecedents that entailed these foci. This is not to say that givenness should not play a role at all in theories of focus: There are theories of focus that make reference to givenness and which are still able to predict these particular slowdowns. For instance, Selkirk's (2008) and Beaver and Velleman's (2011) systems involve both Givenness marking and Focus marking and these theories would be able to predict the slowdowns that are observed on second-occurrence foci in Experiments 6 and 7, because, though given, such foci would still be predicted to be F-marked.

More generally, it seems to be exactly at these types of choice points that behavioral data as presented here has the potential to inform semantic theory. This is because probing the mental representations that comprehenders use on-line may also allow us to distinguish between different ways of representing focus formally. Below I will discuss some future directions that may be able to address these issues in a more concrete way.

6.3 Future directions

The understanding of focus processing outlined above also suggests a number of future directions that are relevant both for theoretical implementations of focus and alternatives and the processing of focus marking and/or the computation of alternative sets.

6.3.1 Mechanisms for alternative set and focus processing

Of course, one large but remaining question involves what exactly the cognitive mechanisms are for maintaining, updating and re-accessing the representations that are discussed throughout this dissertation. For instance, since it is well established that, as humans, we can only hold a limited amount of information activated in our mental workspace (often referred to as our focus of attention) it may be that representations involving contrasts and alternative sets are retrieved from memory whenever the presence of a focusing device indicates such contrasts to be relevant.

Memory retrieval of this type has been used to account for the way different types dependencies are established in discourse, including anaphora (Greene et al., 1992; Foraker & McElree, 2007; Van Dyke & McElree, 2006), presuppositions (Schwarz & Tiemann, 2017) sluices (Martin & McElree, 2011) and ellipsis (Martin & McElree, 2008; Kroll, 2020). For instance, when encountering a pronominal anaphor, comprehenders are argued to launch a search in memory to find its antecedent. This search is typically argued to involve a direct-access cue-matching procedure (McElree et al., 2003; Van Dyke & Lewis, 2003; Lewis & Vasishth, 2005; Van Dyke & McElree, 2006). In such accounts, all available memory representations are compared simultaneously against a set of search cues to find the best match. This means that this search directly accesses those items in memory that match the anaphor in retrieval cues, which can consist of features like number or gender.

It may be that the the comprehension of focus involves a similar mechanism, where perhaps the alternative set is constructed in particular by launching a search in memory for potential alternatives. For instance, when the focus in (3) is identified as a +animate (or perhaps: +human) noun, one could imagine that a search is launched for expressions that match these features.

(3) I think they announced they hired only a lawyer_F last fall, but I'm not sure.

In terms of timing, this search could be launched when the focus is fully identified, but a preliminary search could also be launched earlier, for example at the moment when a focus particle is recognized and a first prediction for the upcoming focus can be made.

However, there are a number of challenges that may need to be overcome first before an unaugmented version of a retrieval account could be adopted for alternative set processing. The first challenge involves the fact that foci are often interpreted with respect to multiple salient alternatives which may be separately introduced in the discourse context. Thus far, it is unclear how multiple such representations may be retrieved or, alternatively, how separate representations may be joined to form a complex set of expressions which can then be retrieved simultaneously. The second challenge involves the role of semantic similarity between foci and their alternative sets: A high level of semantic similarity between multiple potential alternatives do not seem to cause any similarity-based interference effects like those typically observed in the resolution of sentence-internal dependencies. For instance, Experiment 4 as well as Experiments 8-10 included multiple closely related alternatives in the contexts preceding the focus, and yet reading of the focus or any of the surrounding regions did not suggest any interference effects. Future work would have to determine why one of the flagship properties of memory retrieval (similarity-based interference) does not

show up in the same way for the retrieval of alternative sets. What needs to be investigated is thus how memory retrieval may be involved in the processing of alternative sets, whether it is somehow possible that they are held active in comprehenders' focus of attention, or whether alternatives may become activated in some other way, such as via a mechanism that generally allows comprehenders to pre-activate material beyond the unfolding sentence.

6.3.2 Extension to other measures

Another avenue for future research would involve testing the behavioral effects of focus in measures beyond reading, in order to disentangle effects of focus marking itself from effects due to the givenness/newness of material, the presence of prosodic cues to a focus, predictability and answerhood. One concrete next step would be, for instance, to implement materials with multi-word foci like the ones used in Experiment 5 and Experiments 6 and 7 in phoneme-monitoring, memory or priming tasks to test if the behavioral effects typically attributed to focus in fact arise on focused material that is non-accented and/or discourse-given as well. Such extensions could thus provide a better understanding of how the processing of focus is involved in the differential allocation of resources during the comprehension of language.

6.3.3 Finer-grained properties of the alternative set

On the semantics side, one potential future direction could involve further investigating what properties beyond semantic type or replaceability are necessary for expressions to be able to serve as relevant contrastive alternatives (see e.g., Katzir 2007; Wagner 2006b; Katzir 2013; Büring 2019; Buccola et al. 2022). The current experiments suggest, specifically, that this could be done by testing what type of alternatives may or may not facilitate

reading of a downstream focus. Another way of testing this is in how focus is assigned during incremental parsing—for instance in cases like (4) where comprehenders may or may not consider *red* an appropriately contrastive alternative to *high-end* (Wagner, 2006b).

- (4) Mary’s uncle, who produces high-end convertibles, is coming to her wedding. I wonder what he brought as a present.
- a. He brought a CHEAP convertible
 - b. He brought a red CONVERTIBLE.

In this case, comprehenders’ on-line behavior may thus reveal important properties of their reasoning process about contrast as well.

6.3.4 Semantic properties of focus particles

This dissertation mostly studied the processes in ①-③, but there are also many open questions about the role of the (lexical) properties of focus particles themselves. For instance, one potential future direction is to investigate what role the scalar component of scalar particles like *even* may play in creating expectations about the nature of the alternative set. Suggestive evidence for the fact that such information is used incrementally as well was found in Filik et al. (2009), who showed that the scales involved in focus particles allowed comprehenders to form expectations about upcoming material.

6.3.5 Extension to other alternative-based phenomena

Finally, the approach taken in this dissertation could also allow for a comparison with the process of constructing an alternative set for other alternative-based phenomena such as scalar implicature, disjunction, or NPIs. Using similar measures as those presented here,

the time-course at which alternative sets for each of these phenomena are constructed could be investigated. Such a comparison could shed light on whether both the formal characterization of alternative sets and the general cognitive mechanisms through which such alternatives are computed may be the same in these processes, which in turn could shed light on the conceptual differences and commonalities between these phenomena.

Appendix A

Offline acceptability judgments

The offline acceptability judgment studies discussed in this appendix aimed to establish the extent to which the materials used in the Maze task online reading studies were considered natural by native speakers of English. To that end, Experiments A.1-3 use the same stimulus and filler materials as Experiments 1-3. Since reduced acceptability ratings have been shown repeatedly to provide an indication of a significant processing cost, these offline studies also provided preliminary and convergent evidence for potential focus costs.

Participants were from the same population as Experiments 1-3 and recruited in the same way. Sentences were presented using the Ibx Farm platform for web-based experiments (Drummond, 2013).

In each trial, participants read a full dialogue on a single screen and were asked to judge the naturalness of the full discourse on a 4-point Likert scale. The practice items provided guided feedback to make sure participants were familiar with the use of the scale.

All of the studies reported here were analyzed with mixed effects ordinal regression models fitted to the rating data using the `c1mm` function of the ordinal package in R (R Core Team, 2021; Christensen, 2019). All fixed and random effects structures parallel those used for the Maze studies, unless otherwise noted.

A.1 Experiment A.1

Like in Experiment 1, Experiment A.1 manipulated newness and focus within the target sentence by changing the form of the preceding question. For convenience, an example item is repeated below in (1).

- (1) **Speaker A:** This company often makes bad decisions, but...
- | | | |
|----|--|--------------------|
| a. | Did they hire a <u>lawyer</u> last fall, or an <u>accountant</u> ? | NF (alt), given |
| b. | Did they hire a <u>lawyer</u> last fall? | BF (no alt), given |
| c. | Did they hire an <u>accountant</u> last fall? | NF (alt), new |
| d. | What did they announce last time? | BF (no alt), new |

Speaker B: I think they announced they hired a lawyer last fall, but I'm not sure.

This acceptability rating study also aimed to establish whether, in the NF given condition as in (1a), the eventual target word was considered a natural alternative expression to the alternative mentioned the preceding question and vice versa. If the target and the alternative expression were indeed proper alternatives to each other, it would be expected that it would not matter which one was mentioned in the question and which one was mentioned in the target sentence. In Experiment A.1, both the intended question/answer pairs and the question/answer pair in which the position of the target and the alternative expression were switched were tested.

The identity of target and alternative expression was treated as a between-subjects manipulation: one group of participants (n=48) were presented with the set of items that were be used in our reading studies, while a second group of participants (n=48) were

Condition		Target Identity			
NF (alt), given	3.34 (0.043)	alt1	3.36	(0.053)	
		alt2	3.30	(0.055)	
BF (no alt), given	3.29 (0.035)	alt1	3.30	(0.048)	
		alt2	3.27	(0.050)	
NF (alt), new	3.10 (0.039)	alt1	3.16	(0.051)	
		alt2	3.03	(0.059)	
BF (no alt), new	3.10 (0.038)	alt1	3.28	(0.048)	
		alt2	2.81	(0.70)	

Table A.1: Experiment A.1: mean rating and standard error of the mean by condition and by target and presence of alternatives.

presented with the version of all the items that had the target and the alternatives switched.

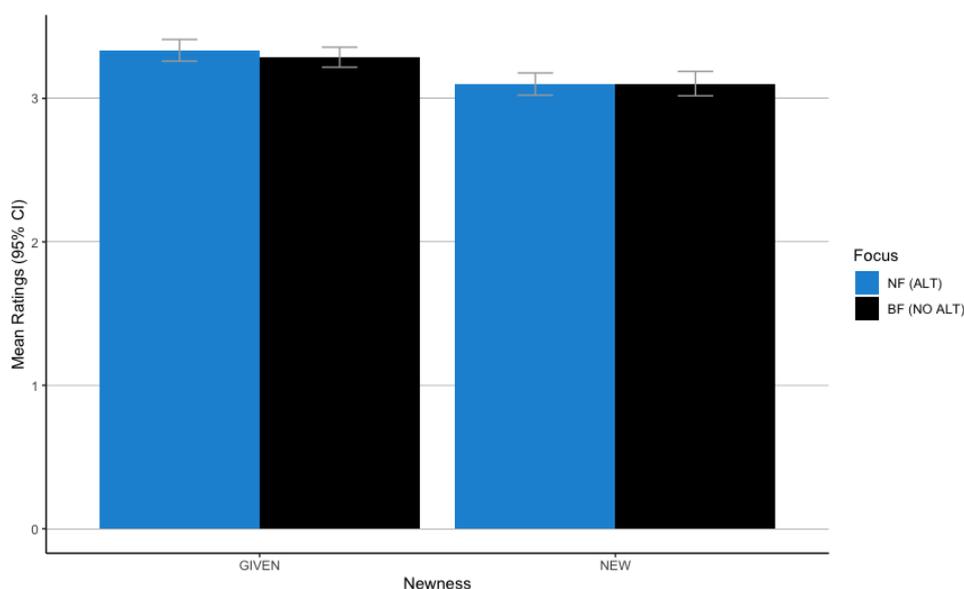


Figure A.1: Experiment A.1: mean rating in each condition. Error bars represent the 95% confidence interval.

In a separate model, the identity of the target word, again with two levels, was added as a between-subjects fixed effect. A t-value of 2 will be considered to be the critical value for significance. The broad focus and given conditions were treated as baselines throughout.

The mixed effects model revealed three significant effects. First, significantly negative estimates of newness indicate that items in which the target was new were rated lower than items with a given target ($z = -5.716, p < 0.001$). Second, significantly negative estimates

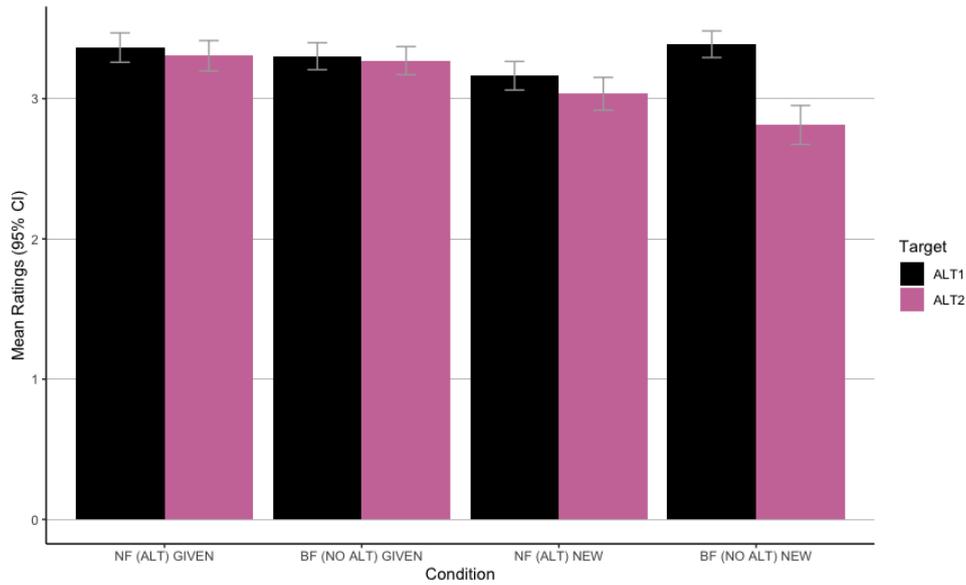


Figure A.2: Experiment A.1: mean rating by alternative in each condition. Error bars represent the 95% confidence interval.

	Estimate	Std. Error	z value
New	-0.8658	0.1515	-5.716
Focus	-0.3615	0.1707	-2.118
New:Focus	0.5338	0.2539	2.102

Table A.2: Parameter values for fixed effects in mixed ordinal regression model of acceptability judgments in Experiment A.1

of focus indicate that stimuli with targets in broad focus were judged less acceptable than stimuli with targets in narrow focus ($z = -2.118, p < 0.05$). Finally, the significantly positive interaction estimate indicated that the effect of newness was smaller in the BF conditions than in the NF conditions ($z = 2.102, p < 0.05$). Pairwise comparisons showed that the newness effect was only significant in the conditions that involved narrow focus ($z = -5.442, p < 0.01$ after Bonferroni-correction for multiple comparisons), while it did not reach significance in the conditions that involved broad focus ($z = -1.633, p < .2$ after correction for multiple comparisons).

The model that included the between-subjects fixed effect did not find a significant

main effect for target identity ($z = -0.322$). However, the triple interaction between target identity, newness and focus turned out to be significant ($z = -4.100, p < 0.001$). Pairwise comparisons revealed that this interaction should be interpreted as indicating that the only significant difference between the two target forms occurred in the BF (no alt), new condition, in which items with alt2 as the target received lower ratings than items with alt1 as the target ($z = -4.286, p < .01$ after applying Bonferroni-corrections for multiple comparisons).

A.2 Experiment A.2

Like Experiment A.1, Experiment A.2 functioned as a norming study for Experiment 2 and as a way to investigate the way in which acceptability ratings are affected by processing cost. The materials employed in Experiment A.2 were completely analogous to those of Experiment A.1, except that Experiment A.2 contained a focus particle in the target sentence, thus putting the target region in narrow focus across conditions. An example item is repeated here in (2) below.

(2) **Speaker A:** This company often makes bad decisions, but...

- a. Did they hire a lawyer last fall, or an accountant? (NF) alt, given
- b. Did they hire a lawyer last fall? (NF) no alt, given
- c. Did they hire an accountant last fall? (NF) alt, new
- d. What did they announce last time? (NF) no alt, new

Speaker B: I think they announced they hired only a lawyer last fall, but I'm not sure.

The same between-subjects manipulation of target identity was used as in Experiment

Condition		Target Identity			
(NF) alt, given	3.30 (0.033)	alt1	3.27	(0.047)	
		alt2	3.34	(0.048)	
(NF) no alt, given	2.77 (0.039)	alt1	2.73	(0.056)	
		alt2	2.82	(0.053)	
(NF) alt, new	3.19 (0.034)	alt1	3.12	(0.051)	
		alt2	3.26	(0.046)	
(NF) no alt, new	3.04 (0.040)	alt1	3.19	(0.052)	
		alt2	2.89	(0.60)	

Table A.3: Experiment A.2: mean rating and standard error of the mean by condition and by target and presence of alternatives.

A.1 to investigate the effect of the specific lexical material making up the target and the alternative expressions.

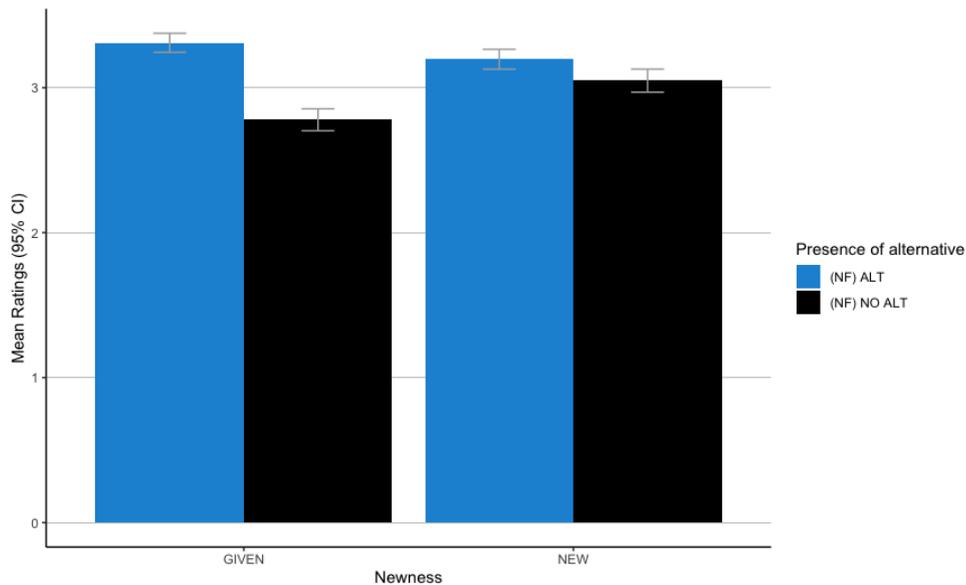


Figure A.3: Experiment A.2: mean rating in each condition. Error bars represent the 95% confidence interval.

In the model including the between-subjects manipulation of target identity, the main effect of target identity did not reach significance ($z = 0.65$). However, this model revealed a significant three-way interaction between target identity, presence of an alternative and newness ($z = -2.55, p < 0.05$). Again, this indicates that acceptability judgments for items with alt2 as the target were only significantly lower than items with alt1 as the target in the

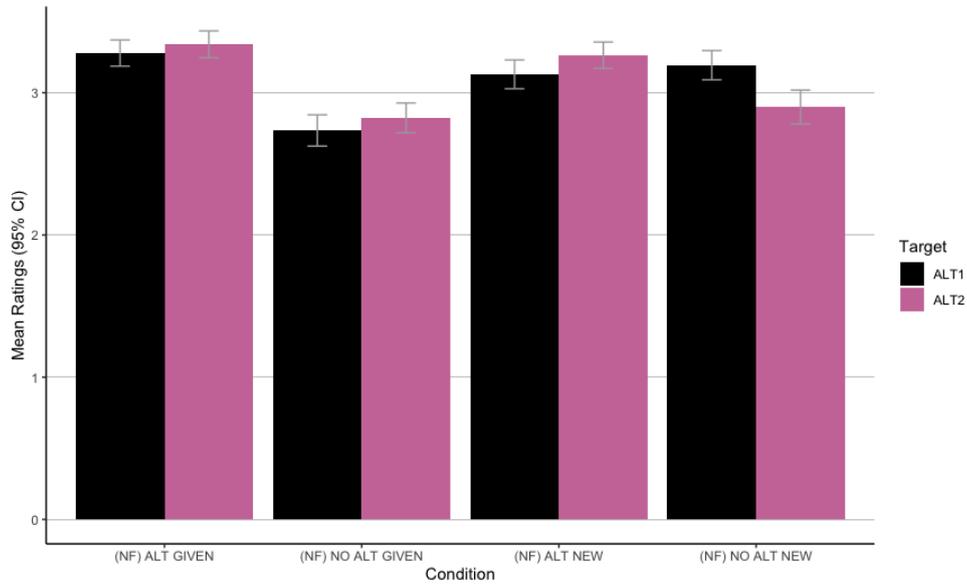


Figure A.4: Experiment A.2: mean rating by alternative in each condition. Error bars represent the 95% confidence interval.

	Estimate	Std. Error	z value
Newness	-0.3194	0.1460	-2.188
Alternative	-1.4143	0.1661	-8.516
Newness:Alternative	0.9407	0.2306	4.079

Table A.4: Parameter values for fixed effects in mixed ordinal regression model of acceptability judgments in Experiment A.2.

(NF) no alt, new condition ($z = -2.989$, $p < 0.05$ after Bonferroni correction for multiple comparisons).

A.3 Experiment A.3

Again like Experiment A.1 and Experiment A.2, Experiment A.3 also functions as a norming study for Experiment 3, in which the same materials are implemented in the Maze task to obtain reading times on the narrow focused region.

(3) **Speaker A:** This company often makes bad decisions, but...

- a. Did they hire a lawyer last fall, or an accountant? (NF) alt, given
- b. Did they hire a lawyer last fall? (NF) no alt, given
- c. Did they hire an accountant last fall? (NF) alt, new
- d. What did they announce last time? (NF) no alt, new

Speaker B: I think they announced it was a lawyer that they hired, but I'm not sure.

Condition		
(NF) alt, given	3.38	(0.03)
(NF) no alt, given	3.05	(0.03)
(NF) alt, new	3.27	(0.03)
(NF) no alt, new	2.86	(0.04)

Table A.5: Experiment A.3: mean rating and standard error of the mean by condition.

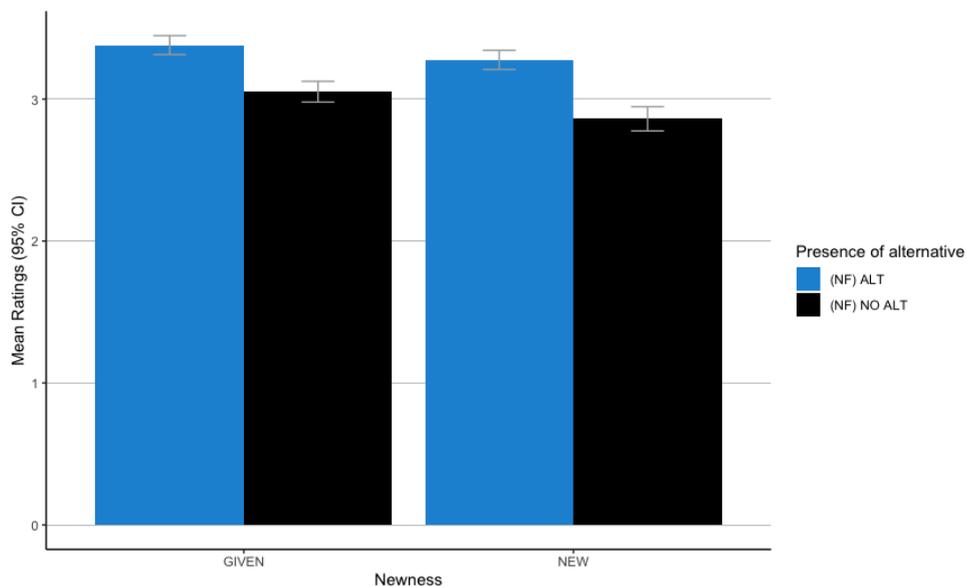


Figure A.5: Experiment A.3: mean rating in each condition. Error bars represent the 95% confidence interval.

The data analysis was again analogous to that of Experiment A.2, except that it did not

include a between-subjects fixed effects for target identity.

	Estimate	Std. Error	z value
Newness	-0.3790	0.1485	-2.552
Alternative	-0.9406	0.1503	-6.257
Newness:Alternative	-0.2012	0.2471	-0.815

Table A.6: Parameter values for fixed effects in mixed ordinal regression model of acceptability judgments in Experiment A.3

The model revealed two significant effects. First, a significantly negative estimate for newness indicated that stimuli in the new conditions were rated significantly lower than stimuli in the given conditions ($z = -2.552, p = 0.01$). Second, a significantly negative estimate for the presence of alternatives suggested that stimuli were rated significantly lower when no alternative to the expression in focus was mentioned, compared to stimuli in conditions in which alternatives were contextually given ($z = -6.257, p < 0.001$).

Appendix B

Materials

B.1 Materials for Experiments 1-3

Materials in all four conditions of Experiment 1			
1	Context:	Abbie is a very picky eater. Did she want chocolate cake for dessert, or apple pie?	NF GIVEN
		Abbie is a very picky eater. Did she want chocolate cake for dessert?	BF GIVEN
		Abbie is a very picky eater. Did she want apple pie for dessert?	NF NEW
		Abbie is a very picky eater. Do you remember what she said?	BF NEW
	Target:	I think Abbie said she wanted chocolate cake for dessert, but I'm not sure.	
2	Context:	Ben is feeling very sick and we're trying to figure out why. Did he eat pasta at the restaurant, or pizza?	NF GIVEN
		Ben is feeling very sick and we're trying to figure out why. Did he eat pasta at the restaurant?	BF GIVEN
		Ben is feeling very sick and we're trying to figure out why. Did he eat pizza at the restaurant?	NF NEW
		Ben is feeling very sick and we're trying to figure out why. What do you remember about yesterday?	BF NEW
	Target:	I think I saw him eating pasta at the restaurant, but it could have been something else.	
3	Context:	We need a few computers for the lab. Did Charlie buy a desktop at the store, or a laptop?	NF GIVEN
		We need a few computers for the lab. Did Charlie buy a desktop at the store?	BF GIVEN
		We need a few computers for the lab. Did Charlie buy a laptop at the store?	NF NEW
		We need a few computers for the lab. What did Charlie tell you again?	BF NEW
	Target:	I think Charlie told me he bought a desktop at the store, although I could be wrong.	
4	Context:	Dave had to get rid of a lot of his stuff. Did he sell his washing machine when he moved out, or his dryer?	NF GIVEN
		Dave had to get rid of a lot of his stuff. Did he sell his washing machine when he moved out?	BF GIVEN
		Dave had to get rid of a lot of his stuff. Did he sell his dryer when he moved out?	NF NEW
		Dave had to get rid of a lot of his stuff. What did he say about it?	BF NEW
	Target:	I believe he said he sold his washing machine when he moved out, but he didn't tell his roommates.	

5	Context:	I wonder how Erik is doing these days. Does he have regrets from his previous marriage, or fond memories?	NF GIVEN
		I wonder how Erik is doing these days. Does he have regrets from his previous marriage?	BF GIVEN
		I wonder how Erik is doing these days. Does he have fond memories from his previous marriage?	NF NEW
		I wonder how Erik is doing these days. What did he say the other day?	BF NEW
	Target:	I believe he said he has regrets from his previous marriage, but I'm not sure.	
6	Context:	I'm looking for someone who can drop this off at work. Are you going to the store today, or to the office?	NF GIVEN
		I'm looking for someone who can drop this off at work. Are you going to the store today?	BF GIVEN
		I'm looking for someone who can drop this off at work. Are you going to the office today?	NF NEW
		I'm looking for someone who can drop this off at work. What did you decide to do?	BF NEW
	Target:	I decided that I am going to the store today, but I might change my mind.	
7	Context:	I'm just trying to figure out the logistics for this weekend. Are you dropping people off at the train station tomorrow afternoon, or at the bus stop?	NF GIVEN
		I'm just trying to figure out the logistics for this weekend. Are you dropping people off at the train station tomorrow afternoon?	BF GIVEN
		I'm just trying to figure out the logistics for this weekend. Are you dropping people off at the bus stop tomorrow afternoon?	NF NEW
		I'm just trying to figure out the logistics for this weekend. What do you think?	BF NEW
	Target:	I think I will be dropping people off at the train station tomorrow afternoon, but I can pick you up wherever.	
8	Context:	I don't know what I should get. Are you drinking beer tonight, or wine?	NF GIVEN
		I don't know what I should get. Are you drinking beer tonight?	BF GIVEN
		I don't know what I should get. Are you drinking wine tonight?	NF NEW
		I don't know what I should get. What do you think?	BF NEW
	Target:	I think I will be drinking beer tonight, but I don't know about the others.	
9	Context:	I wonder how the reimbursement process works. Would it be better to pay with cash tomorrow, or with card?	NF GIVEN
		I wonder how the reimbursement process works. Would it be better to pay with cash tomorrow?	BF GIVEN
		I wonder how the reimbursement process works. Would it be better to pay with card tomorrow?	NF NEW
		I wonder how the reimbursement process works. What did Andrew say?	BF NEW
	Target:	Andrew said it would be better to pay with cash tomorrow, although it doesn't really matter.	
10	Context:	Do you remember, did Faye order rice with her meal, or fries?	NF GIVEN
		Do you remember, did Faye order rice with her meal?	BF GIVEN
		Do you remember, did Faye order fries with her meal?	NF NEW
		Do you remember, what did Faye say just now?	BF NEW
	Target:	I believe she said she ordered rice with her meal, but we should ask her when she's back.	
11	Context:	Greg offered to help me move my stuff next weekend, but does he drive a car these days, or a van?	NF GIVEN
		Greg offered to help me move my stuff next weekend, but does he drive a car these days?	BF GIVEN
		Greg offered to help me move my stuff next weekend, but does he drive a van these days?	NF NEW
		Greg offered to help me move my stuff next weekend, but what did he say exactly?	BF NEW
	Target:	I believe he said he drives a car these days, but I would give him a call.	

12	<p>Context: I'm thinking of buying Hana a birthday present. Has she been a fan of fantasy since her teenage years, or of science fiction? NF GIVEN</p> <p>I'm thinking of buying Hana a birthday present. Has she been a fan of fantasy since her teenage years? BF GIVEN</p> <p>I'm thinking of buying Hana a birthday present. Has she been a fan of science fiction since her teenage years? NF NEW</p> <p>I'm thinking of buying Hana a birthday present. What did she say again? BF NEW</p> <p>Target: I think she said she has been a fan of fantasy since her teenage years, but I'm not sure.</p>
13	<p>Context: I'm not sure what to get at the supermarket. Does Jonathan like vanilla as an ice cream flavor, or strawberry? NF GIVEN</p> <p>I'm not sure what to get at the supermarket. Does Jonathan like vanilla as an ice cream flavor? BF GIVEN</p> <p>I'm not sure what to get at the supermarket. Does Jonathan like strawberry as an ice cream flavor? NF NEW</p> <p>I'm not sure what to get at the supermarket. What did Jonathan say before he left? BF NEW</p> <p>Target: I remember that he said he likes vanilla as an ice cream flavor, although I could be wrong.</p>
14	<p>Context: I might have left my stuff at Kate's place after the event yesterday. Did she find a jacket last night, or a sweater? NF GIVEN</p> <p>I might have left my stuff at Kate's place after the event yesterday. Did she find a jacket last night? BF GIVEN</p> <p>I might have left my stuff at Kate's place after the event yesterday. Did she find a sweater last night? NF NEW</p> <p>I might have left my stuff at Kate's place after the event yesterday. What did she say again? BF NEW</p> <p>Target: I think she said she found a jacket last night, but I would give her a call.</p>
15	<p>Context: I'm trying to find out about the dietary restrictions of our guests. Has Logan been allergic to peanuts ever since she was little, or to seafood? NF GIVEN</p> <p>I'm trying to find out about the dietary restrictions of our guests. Has Logan been allergic to peanuts ever since she was little? BF GIVEN</p> <p>I'm trying to find out about the dietary restrictions of our guests. Has Logan been allergic to seafood ever since she was little? NF NEW</p> <p>I'm trying to find out about the dietary restrictions of our guests. What did Logan say last time? BF NEW</p> <p>Target: I believe she said she has been allergic to peanuts ever since she was little, but I will double check.</p>
16	<p>Context: We have to update your immunization record before we can proceed. Were you vaccinated for tetanus recently, or for chicken pox? NF GIVEN</p> <p>We have to update your immunization record before we can proceed. Were you vaccinated for tetanus recently? BF GIVEN</p> <p>We have to update your immunization record before we can proceed. Were you vaccinated for chicken pox recently? NF NEW</p> <p>We have to update your immunization record before we can proceed. What did your doctor say? BF NEW</p> <p>Target: I think my doctor said I was vaccinated for tetanus recently, although I could be wrong.</p>
17	<p>Context: I'm just wondering who made such a mess on this table. Did Maria read a newspaper this morning, or a magazine? NF GIVEN</p> <p>I'm just wondering who made such a mess on this table. Did Maria read a newspaper this morning? BF GIVEN</p> <p>I'm just wondering who made such a mess on this table. Did Maria read a magazine this morning? NF NEW</p> <p>I'm just wondering who made such a mess on this table. What did Maria say? BF NEW</p> <p>Target: I think she said she was reading a newspaper this morning, but I'm not sure.</p>

18	Context:	I'm looking for some recommendations. Does Tony like to listen to music while driving to work, or to a podcast?	NF GIVEN
		I'm looking for some recommendations. Does Tony like to listen to music while driving to work?	BF GIVEN
		I'm looking for some recommendations. Does Tony like to listen to a podcast while driving to work?	NF NEW
		I'm looking for some recommendations. What did Tony say again?	BF NEW
	Target:	He said he usually likes to listen to music while driving to work, but he has horrible taste.	
19	Context:	I'm trying to gauge his background knowledge. Did he study biology in high school, or chemistry?	NF GIVEN
		I'm trying to gauge his background knowledge. Did he study biology in high school?	BF GIVEN
		I'm trying to gauge his background knowledge. Did he study chemistry in high school?	NF NEW
		I'm trying to gauge his background knowledge. What did he tell you?	BF NEW
	Target:	I remember that he said he studied biology in high school, but you should ask him yourself.	
20	Context:	Oliver really was an annoying kid. Did he always make fun of his mother when he was younger, or of his sister?	NF GIVEN
		Oliver really was an annoying kid. Did he always make fun of his mother when he was younger?	BF GIVEN
		Oliver really was an annoying kid. Did he always make fun of his sister when he was younger?	NF NEW
		Oliver really was an annoying kid. What did his dad say again?	BF NEW
	Target:	I think his dad said he always made fun of his mother when he was younger, but it wasn't too bad.	
21	Context:	I wonder how your mom got the information. Did she talk to a nurse at the hospital, or to a doctor?	NF GIVEN
		I wonder how your mom got the information. Did she talk to a nurse at the hospital?	BF GIVEN
		I wonder how your mom got the information. Did she talk to a doctor at the hospital?	NF NEW
		I wonder how your mom got the information. What did she tell you?	BF NEW
	Target:	I believe she said she talked to a nurse at the hospital, but I might be mistaken.	
22	Context:	I'm not sure what to bring tomorrow night. Are you making a main dish for the dinner party, or a dessert?	NF GIVEN
		I'm not sure what to bring tomorrow night. Are you making a main dish for the dinner party?	BF GIVEN
		I'm not sure what to bring tomorrow night. Are you making a dessert for the dinner party?	NF NEW
		I'm not sure what to bring tomorrow night. What did you decide?	BF NEW
	Target:	I think I decided to make a main dish for the dinner party, but I'm not really a good cook.	
23	Context:	What is your plan for tomorrow? Is your dad coming over for lunch tomorrow, or for dinner?	NF GIVEN
		What is your plan for tomorrow? Is your dad coming over for lunch tomorrow?	BF GIVEN
		What is your plan for tomorrow? Is your dad coming over for dinner tomorrow?	NF NEW
		What is your plan for tomorrow? What did your dad say?	BF NEW
	Target:	I think he said he is coming over for lunch tomorrow, but I will check.	
24	Context:	I was thinking of buying some wool for Liz. Is she knitting a scarf for her granddaughter, or socks?	NF GIVEN
		I was thinking of buying some wool for Liz. Is she knitting a scarf for her granddaughter?	BF GIVEN
		I was thinking of buying some wool for Liz. Is she knitting socks for her granddaughter?	NF NEW
		I was thinking of buying some wool for Liz. What did she say yesterday?	BF NEW
	Target:	I think she said she is knitting a scarf for her granddaughter, but I will ask her again.	

25	Context:	This road has been closed for quite a while now. Are they building a bridge here, or a tunnel?	NF GIVEN
		This road has been closed for quite a while now. Are they building a bridge here?	BF GIVEN
		This road has been closed for quite a while now. Are they building a tunnel here?	NF NEW
		This road has been closed for quite a while now. What do you know about the situation?	BF NEW
	Target:	I think they are building a bridge here, but they will be done very soon.	
26	Context:	I wonder if Rachel already knows about the recent divorce in her family. Did she call her aunt last week, or her uncle?	NF GIVEN
		I wonder if Rachel already knows about the recent divorce in her family. Did she call her aunt last week?	BF GIVEN
		I wonder if Rachel already knows about the recent divorce in her family. Did she call her uncle last week?	NF NEW
		I wonder if Rachel already knows about the recent divorce in her family. What did she tell you last night?	BF NEW
	Target:	I think she said she called her aunt last week, but I don't think she knows anything.	
27	Context:	I'm not sure what is appropriate in this case. Are you giving them money for their wedding, or a giftcard?	NF GIVEN
		I'm not sure what is appropriate in this case. Are you giving them money for their wedding?	BF GIVEN
		I'm not sure what is appropriate in this case. Are you giving them a giftcard for their wedding?	NF NEW
		I'm not sure what is appropriate in this case. What do you think?	BF NEW
	Target:	I think I am giving them money for their wedding, but I might change my mind.	
28	Context:	There was an accident on the highway. Does Stephanie take the bus to school every day, or the train?	NF GIVEN
		There was an accident on the highway. Does Stephanie take the bus to school every day?	BF GIVEN
		There was an accident on the highway. Does Stephanie take the train to school every day?	NF NEW
		There was an accident on the highway. What did Stephanie's mother say?	BF NEW
	Target:	Her mom said Stephanie takes the bus to school every day, but I'm not sure.	
29	Context:	I haven't heard anything yet. Did Dan receive a letter last month, or an email?	NF GIVEN
		I haven't heard anything yet. Did Dan receive a letter last month?	BF GIVEN
		I haven't heard anything yet. Did Dan receive an email last month?	NF NEW
		I haven't heard anything yet. What did Dan tell you?	BF NEW
	Target:	He told me he received a letter last month, but you should just give them a call.	
30	Context:	I'm not sure when we should have our new furniture delivered. Did you paint the walls this week, or the ceiling?	NF GIVEN
		I'm not sure when we should have our new furniture delivered. Did you paint the walls this week?	BF GIVEN
		I'm not sure when we should have our new furniture delivered. Did you paint the ceiling this week?	NF NEW
		I'm not sure when we should have our new furniture delivered. What did you decide?	BF NEW
	Target:	I decided to paint the walls this week, and I hope to be done with the first floor next week.	
31	Context:	I must be going deaf! Did you hear the door bell just now, or the microwave?	NF GIVEN
		I must be going deaf! Did you hear the door bell just now?	BF GIVEN
		I must be going deaf! Did you hear the microwave just now?	NF NEW
		I must be going deaf! What did you say?	BF NEW
	Target:	I said I heard the door bell just now, but I might be wrong.	
32	Context:	I'm updating the roster. Did Tom choose to write a paper for this class, or to take the exam?	NF GIVEN
		I'm updating the roster. Did Tom choose to write a paper for this class?	BF GIVEN
		I'm updating the roster. Did Tom choose to take the exam for this class?	NF NEW
		I'm updating the roster. What did Tom say?	BF NEW
	Target:	I think Tom said he chose to write a paper for this class, but he could change his mind.	

33	Context:	We should find a place to stay for next weekend. Is Caroline renting a house in the city, or an apartment?	NF GIVEN
		We should find a place to stay for next weekend. Is Caroline renting a house in the city?	BF GIVEN
		We should find a place to stay for next weekend. Is Caroline renting an apartment in the city?	NF NEW
		We should find a place to stay for next weekend. Do you remember what Caroline said?	BF NEW
	Target:	I remember Caroline said she is renting a house in the city, but we should ask her again.	
34	Context:	We're almost done with the side dishes, but did Vera cut up cucumbers for the salad, or tomatoes?	NF GIVEN
		We're almost done with the side dishes, but did Vera cut up cucumbers for the salad?	BF GIVEN
		We're almost done with the side dishes, but did Vera cut up tomatoes for the salad?	NF NEW
		We're almost done with the side dishes, but what did Vera say?	BF NEW
	Target:	I think Vera said she cut up cucumbers for the salad, although it doesn't really matter.	
35	Context:	Wendy is not allowed to watch everything. Did she watch a sitcom yesterday, or a documentary?	NF GIVEN
		Wendy is not allowed to watch everything. Did she watch a sitcom yesterday?	BF GIVEN
		Wendy is not allowed to watch everything. Did she watch a documentary yesterday?	NF NEW
		Wendy is not allowed to watch everything. What did she tell you?	BF NEW
	Target:	I believe she said she watched a sitcom yesterday, but I'm not sure.	
36	Context:	Something is different here! Did Saul move the table to the other side of the room, or the sofa?	NF GIVEN
		Something is different here! Did Saul move the table to the other side of the room?	BF GIVEN
		Something is different here! Did Saul move the sofa to the other side of the room?	NF NEW
		Something is different here! What did Saul say?	BF NEW
	Target:	He said he moved the table to the other side of the room, although I'm not sure if I like it.	
37	Context:	This company often makes the wrong decisions. Did they hire a lawyer last fall, or an accountant?	NF GIVEN
		This company often makes the wrong decisions. Did they hire a lawyer last fall?	BF GIVEN
		This company often makes the wrong decisions. Did they hire an accountant last fall?	NF NEW
		This company often makes the wrong decisions. What did they announce this time?	BF NEW
	Target:	I think they announced that they hired a lawyer last fall, but I might be wrong.	
38	Context:	What are you doing for the holidays? Are you celebrating new year's with family this year, or with friends?	NF GIVEN
		What are you doing for the holidays? Are you celebrating new year's with family this year?	BF GIVEN
		What are you doing for the holidays? Are you celebrating new year's with friends this year?	NF NEW
		What are you doing for the holidays? What did you decide?	BF NEW
	Target:	I decided I will celebrate new year's with family this year, but I might change my mind.	
39	Context:	I'm making the same recipe as Zara did last time. Did she use basil for the sauce, or parsley?	NF GIVEN
		I'm making the same recipe as Zara did last time. Did she use basil for the sauce?	BF GIVEN
		I'm making the same recipe as Zara did last time. Did she use parsley for the sauce?	NF NEW
		I'm making the same recipe as Zara did last time. What did she say?	BF NEW
	Target:	She said she used basil for the sauce, although I could be wrong.	

40	Context:	The police are trying to find out how the burglar got in. Did Amanda close the door when it got cold, or the window?	NF GIVEN
		The police are trying to find out how the burglar got in. Did Amanda close the door when it got cold?	BF GIVEN
		The police are trying to find out how the burglar got in. Did Amanda close the window when it got cold?	NF NEW
		The police are trying to find out how the burglar got in. What did Amanda tell them?	BF NEW
	Target:	I think she said she closed the door when it got cold, but she didn't lock it.	
41	Context:	I'm making Bill's schedule right now. Is he teaching on Tuesdays this quarter, or on Wednesdays?	NF GIVEN
		I'm making Bill's schedule right now. Is he teaching on Tuesdays this quarter?	BF GIVEN
		I'm making Bill's schedule right now. Is he teaching on Wednesdays this quarter?	NF NEW
		I'm making Bill's schedule right now. What did he tell you?	BF NEW
	Target:	I believe he said he will be teaching on Tuesdays this quarter, but I'm not sure.	
42	Context:	I don't know what the weather will be like. Should I wear shorts today, or jeans?	NF GIVEN
		I don't know what the weather will be like. Should I wear shorts today?	BF GIVEN
		I don't know what the weather will be like. Should I wear jeans today?	NF NEW
		I don't know what the weather will be like. What do you think?	BF NEW
	Target:	I think you should wear shorts today, but you should decide for yourself.	
43	Context:	I wonder if we have all the ingredients already. Do you still need milk for this recipe, or eggs?	NF GIVEN
		I wonder if we have all the ingredients already. Do you still need milk for this recipe?	BF GIVEN
		I wonder if we have all the ingredients already. Do you still need eggs for this recipe?	NF NEW
		I wonder if we have all the ingredients already. What do you think?	BF NEW
	Target:	I think we still need milk for this recipe, but I will check the fridge.	
44	Context:	I'm trying to decide if I should make a reservation. Would you like to sit in the back during the show, or in the front?	NF GIVEN
		I'm trying to decide if I should make a reservation. Would you like to sit in the back during the show?	BF GIVEN
		I'm trying to decide if I should make a reservation. Would you like to sit in the front during the show?	NF NEW
		I'm trying to decide if I should make a reservation. What do you think?	BF NEW
	Target:	I think I would like to sit in the back during the show, but you don't have to make a reservation.	
45	Context:	What was going on? Was Jack looking for his wallet in the car, or for his keys?	NF GIVEN
		What was going on? Was Jack looking for his wallet in the car?	BF GIVEN
		What was going on? Was Jack looking for his keys in the car?	NF NEW
		What was going on? What did Jack tell you?	BF NEW
	Target:	I think he said he was looking for his wallet in the car, but he didn't find anything.	
46	Context:	We're trying to give away the leftovers. Did Claire bring the roasted vegetables to the potluck, or the fruit salad?	NF GIVEN
		We're trying to give away the leftovers. Did Claire bring the roasted vegetables to the potluck?	BF GIVEN
		We're trying to give away the leftovers. Did Claire bring the fruit salad to the potluck?	NF NEW
		We're trying to give away the leftovers. What did Claire say?	BF NEW
	Target:	I believe she said she brought the roasted vegetables to the potluck, but we should ask her again.	
47	Context:	Yesterday the jewelry store was held up. Did the thief steal a bracelet from the store, or a necklace?	NF GIVEN
		Yesterday the jewelry store was held up. Did the thief steal a bracelet from the store?	BF GIVEN
		Yesterday the jewelry store was held up. Did the thief steal a necklace from the store?	NF NEW
		Yesterday the jewelry store was held up. What did you hear about it?	BF NEW
	Target:	I heard that they stole a bracelet from the store, and it wasn't a very expensive one.	
48	Context:	We already did a lot of chores today! Did Dean do the dishes this morning, or the laundry?	NF GIVEN
		We already did a lot of chores today! Did Dean do the dishes this morning?	BF GIVEN
		We already did a lot of chores today! Did Dean do the laundry this morning?	NF NEW
		We already did a lot of chores today! What did Dean tell you?	BF NEW
	Target:	He said he did the dishes this morning, but I'm not sure.	

B.2 Foci, alternatives and primes for Exp. 4

item	focus (target)	assoc. alt	LSA targ.	nonassoc. alt	LSA targ.	assoc non-alt	LSA targ.
1	swan	duck	0.43	fish	0.14	nest	0.49
2	puppy	kitten	0.43	dinosaur	0.04	furry	0.44
3	sleet	snow	0.50	leaves	0.09	frozen	0.67
4	garden	lawn	0.41	sidewalk	0.39	hoe	0.56
5	ponies	horses	0.79	ducks	0.06	riding	0.70
6	newspapers	magazines	0.75	cigarettes	0.06	reporter	0.80
7	toad	turtle	0.59	bee	0.10	pond	0.49
8	oranges	lemons	0.67	candle	-0.06	sour	0.67
9	chair	table	0.61	flowerpot	0.03	dinner	0.57
10	tv	radio	0.70	bike	0.01	viewing	0.79
11	chemistry	biology	0.68	sports	0.04	transformative	0.60
12	church	cathedral	0.43	post office	0.06	priest	0.39
13	eel	anemone	0.37	rock	0.14	slimy	0.41
14	wool	cotton	0.67	metal	0.02	dyed	0.57
15	windows	doors	0.66	tape	0.08	open	0.73
16	tulips	roses	0.58	card	-0.01	pink	0.48
17	rice	noodle	0.43	parchment paper	0.00	fried	0.43
18	muffins	cake	0.52	swords	0.02	birthday	0.50
19	hurricane	earthquake	0.31	kidnapping	0.08	clouds	0.41
20	airplane	helicopter	0.62	bus	0.13	fly	0.68
21	tomatoes	cucumbers	0.58	beers	0.02	cooking	0.50
22	jeans	scarf	0.45	book	0.11	skinny	0.35
23	sculptor	painter	0.58	lawyer	0.09	statue	0.52
24	stove	oven	0.57	garage	0.11	pan	0.51
25	flour	milk	0.56	sponges	-0.01	baking	0.59
26	sweater	jacket	0.56	puzzle	0.07	wool	0.49
27	umbrella	raincoat	0.38	sunscreen	0.01	raining	0.4
28	moon	sun	0.28	locket	0.03	bright	0.39
29	napkin	fork	0.43	flowers	0.04	lap	0.36

30	pipe	cigarette	0.30	incense	0.12	lungs	0.33
31	leash	collar	0.42	nail clippers	0.13	leather	0.39
32	pillows	blankets	0.54	food	0.03	couch	0.54
33	doctors	nurses	0.52	carpenters	0.02	clinic	0.57
34	pears	apples	0.51	salmon	0.05	ripe	0.52
35	soap	shampoo	0.50	vitamins	0.02	dermatologists	0.55
36	parsley	thyme	0.49	candy	0.12	soup chef	0.53
37	cherries	strawberries	0.48	toilet paper	0.04	cakes	0.49
38	sink	faucet	0.48	alarm system	0.04	water	0.59
39	kayaks	canoes	0.47	camper vans	0.06	island	0.43
40	eyeshadow	lipstick	0.46	keys	0.09	saleslady	0.43
41	goats	sheep	0.46	fish	0.04	grass	0.47
42	pizza	pasta	0.44	water	0.02	pastry	0.49
43	gloves	scarves	0.44	teapots	0.1	bag 0	.52
44	pin	palms	0.43	tulips	0.04	trees	0.68
45	nails	screws	0.43	lightbulb	-0.03	sanding	0.39
46	necklace	tiara	0.32	computer	0.02	posh	0.28
47	bacteria	parasite	0.52	hernia	0.03	microscope	0.42
48	apartments	houses	0.40	bridge	0.06	construction	0.33

B.3 Materials for Experiment 5

Item	Materials	Condition
1	Context: I saw that Abby was working on the computer for a while...	
	a. Did she write a recipe for a cake, or a pie?	NARROW-NP
	b. Did she write a recipe for a cake, or a review of a pie?	WIDE-NP
	c. Did she write a recipe for a cake, or read a review of a pie?	VP
	d. Did she write a recipe for a cake?	BROAD
	Target: I think Abby said she wrote a recipe for a cake, but I'm not sure.	
2	Context: I'm wondering if we have enough food for the party...	
	a. Did Elena order a box of pasta, or rice?	NARROW-NP
	b. Did Elena order a box of pasta, or a bag of rice?	WIDE-NP
	c. Did Elena order a box of pasta, or bring a bag of rice?	VP
	d. Did Elena order a box of pasta?	BROAD
	Target: I think Elena said she ordered a box of pasta, but I could be wrong.	

3	<p>Context: Mariella was making a lot of noise in the office yesterday...</p> <p>a. Did she break a cable for the desktop, or the laptop? NARROW-NP</p> <p>b. Did she break a cable for the desktop, or a button on the laptop? WIDE-NP</p> <p>c. Did she break a cable for the desktop, or fix a button on the laptop? VP</p> <p>d. Did she break a cable for the desktop? BROAD</p> <p>Target: I think Mariella said she broke a cable for the desktop, but maybe I'm wrong.</p>
4	<p>Context: Leon is trying to remove some of the clutter in his garage...</p> <p>a. but did he build a shed for his washing machine, or his dryer? NARROW-NP</p> <p>b. but did he build a shed for his washing machine, or a room for his dryer? WIDE-NP</p> <p>c. but did he build a shed for his washing machine, or refurbish a room for his dryer? VP</p> <p>d. but did he build a shed for his washing machine? BROAD</p> <p>Target: I think Leon said he built a shed for his washing machine, though I could be wrong.</p>
5	<p>Context: I know that Claire works in the film industry...</p> <p>a. But I forget: did she direct a movie about birth, or death? NARROW-NP</p> <p>b. But I forget: did she direct a movie about birth, or a play about death? WIDE-NP</p> <p>c. But I forget: did she direct a movie about birth, or act in a play about death? VP</p> <p>d. But I forget: did she direct a movie about birth? BROAD</p> <p>Target: I think Abby said she directed a movie about birth, but I'm not entirely sure.</p>
6	<p>Context: Sarah has good taste when it comes to media...</p> <p>a. Did she recommend a documentary about dolphins, or sharks? NARROW-NP</p> <p>b. Did she recommend a documentary about dolphins, or a podcast about sharks? WIDE-NP</p> <p>c. Did she recommend a documentary about dolphins, or complain about a podcast about sharks? VP</p> <p>d. Did she recommend a documentary about dolphins? BROAD</p> <p>Target: I think Sarah said she recommended a documentary about dolphins, but I might be forgetting something.</p>
7	<p>Context: Alice was busy running some errands yesterday...</p> <p>a. Did she pick up food for the dogs, or the cats? NARROW-NP</p> <p>b. Did she pick up food for the dogs, or toys for the cats? WIDE-NP</p> <p>c. Did she pick up food for the dogs, or drop off toys for the cats? VP</p>

		d. Did she pick up food for the dogs?	BROAD
	Target:	I think Alice said she picked up food for the dogs, but I'm not sure.	
8	Context:	We're trying to figure out how to split the cost of the party...	
		a. Did Charlotte drink a glass of wine, or beer?	NARROW-NP
		b. Did Charlotte drink a glass of wine, or a bottle of beer?	WIDE-NP
		c. Did Charlotte drink a glass of wine, or bring a bottle of beer?	VP
		d. Did Charlotte drink a glass of wine?	BROAD
	Target:	I think Charlotte said she drank a glass of wine, but I could be wrong.	
9	Context:	The post office called because they lost some mail...	
		a. Did Jessie receive a package with a letter, or an invitation?	NARROW-NP
		b. Did Jessie receive a package with a letter, or an envelope with an invitation?	WIDE-NP
		c. Did Jessie receive a package with a letter, or send an envelope with an invitation?	VP
		d. Did Jessie receive a package with a letter?	BROAD
	Target:	I think Jessie said she received a package with a letter, but maybe I'm wrong.	
10	Context:	We're trying to figure out what all this stuff is on the floor...	
		a. Did Maria spill a bowl of yogurt, or cottage cheese?	NARROW-NP
		b. Did Maria spill a bowl of yogurt, or a cup of cottage cheese?	WIDE-NP
		c. Did Maria spill a bowl of yogurt, or throw up a cup of cottage cheese?	VP
		d. Did Maria spill a bowl of yogurt?	BROAD
	Target:	I think Maria said she spilt a bowl of yogurt, though I could be wrong.	
11	Context:	I heard John solved his parking space issues...	
		a. Does he rent a parking spot for his car, or his van?	NARROW-NP
		b. Does he rent a parking spot for his car, or a garage for his van?	WIDE-NP
		c. Does he rent a parking spot for his car, or own a garage for his van?	VP
		d. Does he rent a parking spot for his car?	BROAD
	Target:	I think John said he rented a parking spot for his car, but I'm not entirely sure.	
12	Context:	Kyle kind of lives in his own little world...	
		a. Does he oversee art for board games, or comics?	NARROW-NP
		b. Does he oversee art for board games, or narratives for comics?	WIDE-NP
		c. Does he oversee art for board games, or write narratives for comics?	VP

		d. Does he oversee art for board games?	BROAD
	Target:	I think Kyle said he oversees art for board games, but I might be forgetting something.	
13	Context:	I'm trying to figure out what to get when Julia comes over...	
		a. Does she like tea with chocolate, or biscuits?	NARROW-NP
		b. Does she like tea with chocolate, or coffee with biscuits?	WIDE-NP
		c. Does she like tea with chocolate, or hate coffee with biscuits?	VP
		d. Does she like tea with chocolate?	BROAD
	Target:	I think Julia said she liked tea with chocolate, but I'm not sure.	
14	Context:	There is paint all over the floor in the garage!...	
		a. Did Ali tie-dye the front of a jacket, or a sweater?	NARROW-NP
		b. Did Ali tie-dye the front of a jacket, or the back of a sweater?	WIDE-NP
		c. Did Ali tie-dye the front of a jacket, or spray-paint the back of a sweater?	VP
		d. Did Ali tie-dye the front of a jacket?	BROAD
	Target:	I think Ali said he tie-dyed the front of a jacket, but I could be wrong.	
15	Context:	I'm trying to remember if any of our guests have any dietary restrictions...	
		a. Was Adriene born with an allergy to peanuts, or cashews?	NARROW-NP
		b. Was Adriene born with an allergy to peanuts, or an intolerance for cashews?	WIDE-NP
		c. Was Adriene born with an allergy to peanuts, or briefly afflicted by an intolerance for cashews?	VP
		d. Was Adriene born with an allergy to peanuts?	BROAD
	Target:	I think Adriene said she was born with an allergy to peanuts, but maybe I'm wrong.	
16	Context:	We need to know all the details to solve this case...	
		a. When you entered the room, did Benji sit on a chair made of cotton, or leather?	NARROW-NP
		b. When you entered the room, did Benji sit on a chair made of cotton, or a sofa made of leather?	WIDE-NP
		c. When you entered the room, did Benji sit on a chair made of cotton, or lay on a sofa made of leather?	VP
		d. When you entered the room, did Benji sit on a chair made of cotton?	BROAD
	Target:	I think Benji said he sat on a chair made of cotton, though I could be wrong.	

17	Context:	I heard some stuff about Chelsea, but remind me...	
	a.	was she quoted in an article in a newspaper, or a magazine?	NARROW-NP
	b.	was she quoted in an article in a newspaper, or a feature in a magazine?	WIDE-NP
	c.	was she quoted in an article in a newspaper, or profiled in a feature in a magazine?	VP
	d.	was she quoted in an article in a newspaper?	BROAD
	Target:	I think Chelsea said she was quoted in an article in a newspaper, but I'm not entirely sure.	
18	Context:	This soup tastes horrible...	
	a.	Did Kaitlin add a tablespoon of salt, or pepper?	NARROW-NP
	b.	Did Kaitlin add a tablespoon of salt, or a teaspoon of pepper?	WIDE-NP
	c.	Did Kaitlin add a tablespoon of salt, or leave out a teaspoon of pepper?	VP
	d.	Did Kaitlin add a tablespoon of salt?	BROAD
	Target:	I think Kaitlin said she added a tablespoon of salt, but I might be forgetting something.	
19	Context:	Yesterday, Eli was studying in his room...	
	a.	Did he devote himself to a lab for biology, or chemistry?	NARROW-NP
	b.	Did he devote himself to a lab for biology, or a textbook on chemistry?	WIDE-NP
	c.	Did he devote himself to a lab for biology, or skim a textbook on chemistry?	VP
	d.	Did he devote himself to a lab for biology?	BROAD
	Target:	I think Eli said he devoted himself to a lab on biology, but I'm not sure.	
20	Context:	I heard some gossip about the party last weekend...	
	a.	Did Nikolas come with a friend of his mother, or his sister?	NARROW-NP
	b.	Did Nikolas come with a friend of his mother, or a colleague of his sister?	WIDE-NP
	c.	Did Nikolas come with a friend of his mother, or leave with a colleague of his sister?	VP
	d.	Did Nikolas come with a friend of his mother?	BROAD
	Target:	I think Nikolas said he came with a friend of his mother, but I could be wrong.	
21	Context:	I heard there is some big news...	
	a.	Did Jedidiah obtain a certificate to be a nurse, or a doctor?	NARROW-NP
	b.	Did Jedidiah obtain a certificate to be a nurse, or a license to be a doctor?	WIDE-NP
	c.	Did Jedidiah obtain a certificate to be a nurse, or lose a license to be a doctor?	VP
	d.	Did Jedidiah obtain a certificate to be a nurse?	BROAD

	Target:	I think Jedidiah said he obtained a certificate to be a nurse, but maybe I'm wrong.	
22	Context:	Andrew helped out on the farm this week...	
	a.	Did he fence off a field for the cows, or the horses?	NARROW-NP
	b.	Did he fence off a field for the cows, or a stable for the horses?	WIDE-NP
	c.	Did he fence off a field for the cows, or set up a stable for the horses?	VP
	d.	Did he fence off a field for the cows?	BROAD
	Target:	I think Andrew said he fenced off a field for the cows, though I could be wrong.	
23	Context:	I'm trying to keep his calendar up-to-date, ...	
	a.	so did Bruno cancel a lunch with his wife, or his daughter?	NARROW-NP
	b.	so did Bruno cancel a lunch with his wife, or a dinner with his daughter?	WIDE-NP
	c.	so did Bruno cancel a lunch with his wife, or schedule a dinner with his daughter?	VP
	d.	so did Bruno cancel a lunch with his wife?	BROAD
	Target:	I think Bruno said he cancelled a lunch with his wife, but I'm not entirely sure.	
24	Context:	Bertha said something about knitting...	
	a.	Did she find a knitting pattern for a scarf, or a hat?	NARROW-NP
	b.	Did she find a knitting pattern for a scarf, or materials for a hat?	WIDE-NP
	c.	Did she find a knitting pattern for a scarf, or lose materials for a hat?	VP
	d.	Did she find a knitting pattern for a scarf?	BROAD
	Target:	I think Bertha said she found a knitting pattern for a scarf, but I might be forgetting something.	
25	Context:	Dorothee was working on some art project...	
	a.	Did she sketch a schema of a bridge, or a tunnel?	NARROW-NP
	b.	Did she sketch a schema of a bridge, or a picture of a tunnel?	WIDE-NP
	c.	Did she sketch a schema of a bridge, or paint a picture of a tunnel?	VP
	d.	Did she sketch a schema of a bridge?	BROAD
	Target:	I think Dorothee said she sketched a schema of a bridge, but I'm not sure.	
26	Context:	I'm confused...	
	a.	did Mariana send a text about her aunt, or her uncle?	NARROW-NP
	b.	did Mariana send a text about her aunt, or an email about her uncle?	WIDE-NP

		c. did Mariana send a text about her aunt, or delete an email about her uncle?	VP
		d. did Mariana send a text about her aunt?	BROAD
	Target:	I think Mariana said she sent a text about her aunt, but I could be wrong.	
27	Context:	I always have a hard time figuring out what to give people during events like this...	
		a. Did Briana get a giftcard for her birthday, or her wedding?	NARROW-NP
		b. Did Briana get a giftcard for her birthday, or money for her wedding?	WIDE-NP
		c. Did Briana get a giftcard for her birthday, or ask for money for her wedding?	VP
		d. Did Briana get a giftcard for her birthday?	BROAD
	Target:	I think Briana said she got a giftcard for her birthday, but maybe I'm wrong.	
28	Context:	Jackson's bike is broken...	
		a. Did he crash into the corner of a bus, or a tram?	NARROW-NP
		b. Did he crash into the corner of a bus, or the side of a tram?	WIDE-NP
		c. Did he crash into the corner of a bus, or graze the side of a tram?	VP
		d. Did he crash into the corner of a bus?	BROAD
	Target:	I think Jackson said he crashed into the corner of a bus, though I could be wrong.	
29	Context:	We're trying to figure out how much stuff we still need at the crisis center...	
		a. Did Omar bring a onesie for a baby, or a toddler?	NARROW-NP
		b. Did Omar bring a onesie for a baby, or a blanket for a toddler?	WIDE-NP
		c. Did Omar bring a onesie for a baby, or request a blanket for a toddler?	VP
		d. Did Omar bring a onesie for a baby?	BROAD
	Target:	I think Omar said he brought a onesie for a baby, but I'm not entirely sure.	
30	Context:	I'm trying to figure out what still needs to be done...	
		a. Did Anastasia remove paint from the walls, or the ceiling?	NARROW-NP
		b. Did Anastasia remove paint from the walls, or wallpaper on the ceiling?	WIDE-NP
		c. Did Anastasia remove paint from the walls, or replace wallpaper on the ceiling?	VP
		d. Did Anastasia remove paint from the walls?	BROAD
	Target:	I think Anastasia said she removed paint from the walls, but I might be forgetting something.	

31	Context:	So what happened next...	
	a.	Did Zoe hear the buzz of the door bell, or the microwave	NARROW-NP
	b.	Did Zoe hear the buzz of the door bell, or the beep of the microwave	WIDE-NP
	c.	Did Zoe hear the buzz of the door bell, or ignore the beep of the microwave	VP
	d.	Did Zoe hear the buzz of the door bell	BROAD
	Target:	I think Zoe said she heard the buzz of the door bell, but I'm not sure.	
32	Context:	Carlos stayed up late working yesterday...	
	a.	Did he edit a paper about climate change, or inflation?	NARROW-NP
	b.	Did he edit a paper about climate change, or a report about inflation?	WIDE-NP
	c.	Did he edit a paper about climate change, or review a report about inflation?	VP
	d.	Did he edit a paper about climate change?	BROAD
	Target:	I think Carlos said he edited a paper about climate change, but I could be wrong.	
33	Context:	I haven't had any updates about Sanjiv's housing situation recently...	
	a.	Did he rent a house with a garden, or a balcony?	NARROW-NP
	b.	Did he rent a house with a garden, or an apartment with a balcony?	WIDE-NP
	c.	Did he rent a house with a garden, or sublet an apartment with a balcony?	VP
	d.	Did he rent a house with a garden?	BROAD
	Target:	I think Sanjiv said he rented a house with a garden, but maybe I'm wrong.	
34	Context:	I saw Delphine in the vegetable garden yesterday...	
	a.	Did she fill up a basket of cucumbers, or tomatoes?	NARROW-NP
	b.	Did she fill up a basket of cucumbers, or a bucket of tomatoes?	WIDE-NP
	c.	Did she fill up a basket of cucumbers, or empty out a bucket of tomatoes?	VP
	d.	Did she fill up a basket of cucumbers?	BROAD
	Target:	I think Delphine said she filled up a basket of cucumbers, though I could be wrong.	
35	Context:	So what happened in the story again...	
	a.	Did Guiseppe fall asleep in a circle of palms, or pines	NARROW-NP
	b.	Did Guiseppe fall asleep in a circle of palms, or a grove of pines	WIDE-NP
	c.	Did Guiseppe fall asleep in a circle of palms, or wake up in a grove of pines	VP

	Target:	d. Did Guiseppe fall asleep in a circle of palms I think Guiseppe said he fell asleep in a circle of palms, but I'm not entirely sure.	BROAD
36	Context:	I wonder who cleaned the bathroom...	
		a. Did Esmael scrub the inside of the toilet, or the sink?	NARROW-NP
		b. Did Esmael scrub the inside of the toilet, or the surface of the sink?	WIDE-NP
		c. Did Esmael scrub the inside of the toilet, or dust the surface of the sink?	VP
	Target:	d. Did Esmael scrub the inside of the toilet? I think Esmael said he scrubbed the inside of the toilet, but I might be forgetting something.	BROAD
37	Context:	I always lose track of all the gossip, so remind me...	
		a. did Lucy marry the brother of a lawyer, or an accountant?	NARROW-NP
		b. did Lucy marry the brother of a lawyer, or the cousin of an accountant?	WIDE-NP
		c. did Lucy marry the brother of a lawyer, or date the cousin of an accountant?	VP
	Target:	d. did Lucy marry the brother of a lawyer? I think Lucy said she married the brother of a lawyer, but I'm not sure.	BROAD
38	Context:	I didn't really pay attention to Diana's drunk rant yesterday...	
		a. Did she value the importance of family, or friends?	NARROW-NP
		b. Did she value the importance of family, or the comfort of friends?	WIDE-NP
		c. Did she value the importance of family, or dismiss the comfort of friends?	VP
	Target:	d. Did she value the importance of family? I think Diana said she valued the importance of family, but I could be wrong.	BROAD
39	Context:	I wonder if we have all the ingredients to make this pasta dish...	
		a. Did Anais buy a handful of basil, or parsley?	NARROW-NP
		b. Did Anais buy a handful of basil, or a bunch of parsley?	WIDE-NP
		c. Did Anais buy a handful of basil, or grow a bunch of parsley?	VP
	Target:	d. Did Anais buy a handful of basil? I think Anais said she bought a handful of basil, but maybe I'm wrong.	BROAD
40	Context:	We're trying to figure out how the bike was stolen...	
		a. Yesterday evening, did Alexandra open the doors to the shed, or the garage?	NARROW-NP

		b. Yesterday evening, did Alexandra open the doors to the shed, or the windows of the garage?	WIDE-NP
		c. Yesterday evening, did Alexandra open the doors to the shed, or close the windows of the garage?	VP
		d. Yesterday evening, did Alexandra open the doors to the shed?	BROAD
	Target:	I think Alexandra said she opened the doors to the shed, though I could be wrong.	
41	Context:	Remind me...	
		a. did Bernard run late for his soccer practice on Tuesday, or Wednesday	NARROW-NP
		b. did Bernard run late for his soccer practice on Tuesday, or his piano lesson on Wednesday	WIDE-NP
		c. did Bernard run late for his soccer practice on Tuesday, or miss his piano lesson on Wednesday	VP
		d. did Bernard run late for his soccer practice on Tuesday	BROAD
	Target:	I think Bernard said he ran late for his soccer practice on Tuesday, but I'm not entirely sure.	
42	Context:	What did Valentina say just a minute ago...	
		a. Did she fancy the tall guy with the shorts, or the jeans	NARROW-NP
		b. Did she fancy the tall guy with the shorts, or the short guy with the jeans	WIDE-NP
		c. Did she fancy the tall guy with the shorts, or detest the short guy with the jeans	VP
		d. Did she fancy the tall guy with the shorts	BROAD
	Target:	I think Valentina said she fancied the tall guy with the shorts, but I might be forgetting something.	
43	Context:	Hasim always eats a lot...	
		a. This morning, did he consume an entire carton of milk, or eggs?	NARROW-NP
		b. This morning, did he consume an entire carton of milk, or half a dozen eggs?	WIDE-NP
		c. This morning, did he consume an entire carton of milk, or scramble half a dozen eggs?	VP
		d. This morning, did he consume an entire carton of milk?	BROAD
	Target:	I think Hasim said he consumed an entire carton of milk, but I'm not sure.	
44	Context:	I wonder how much cleaning still needs to be done...	
		a. Did Simon dust the cabinet in the bathroom, or the bedroom?	NARROW-NP
		b. Did Simon dust the cabinet in the bathroom, or the closet in the bedroom?	WIDE-NP

		c. Did Simon dust the cabinet in the bathroom, or organize the closet in the bedroom?	VP
		d. Did Simon dust the cabinet in the bathroom?	BROAD
	Target:	I think Simon said he dusted the cabinet in the bathroom, but I could be wrong.	
45	Context:	The police need some more details about what happened last night...	
		a. Did Igor find a bag with a wallet, or keys?	NARROW-NP
		b. Did Igor find a bag with a wallet, or a purse with keys?	WIDE-NP
		c. Did Igor find a bag with a wallet, or steal a purse with keys?	VP
		d. Did Igor find a bag with a wallet?	BROAD
	Target:	I think Igor said he found a bag with a wallet, but maybe I'm wrong.	
46	Context:	So what happened during the dinner yesterday...	
		a. Did Maeve ask for an entree with meat, or dairy	NARROW-NP
		b. Did Maeve ask for an entree with meat, or a dessert with dairy	WIDE-NP
		c. Did Maeve ask for an entree with meat, or refuse a dessert with dairy	VP
		d. Did Maeve ask for an entree with meat	BROAD
	Target:	I think Maeve said she asked for an entree with meat, though I could be wrong.	
47	Context:	Remind me what happened to Lara's jewelry collection...	
		a. Did she give away the charm on her bracelet, or her necklace?	NARROW-NP
		b. Did she give away the charm on her bracelet, or the pendant on her necklace?	WIDE-NP
		c. Did she give away the charm on her bracelet, or pawn the pendant on her necklace?	VP
		d. Did she give away the charm on her bracelet?	BROAD
	Target:	I think Lara said she gave away the charm on her bracelet, but I'm not entirely sure.	
48	Context:	Ursula always wakes up very early to do some chores...	
		a. This morning, did she wash a stack of dishes, or laundry?	NARROW-NP
		b. This morning, did she wash a stack of dishes, or a load of laundry?	WIDE-NP
		c. This morning, did she wash a stack of dishes, or fold a load of laundry?	VP
		d. This morning, did she wash a stack of dishes?	BROAD
49	Context:	I'm trying to clean up this drawer with documents,...	
		a. but did Rebecca save the manual for the oven, or the microwave?	NARROW-NP

		a. but did Rebecca save the manual for the oven, or the microwave?	NARROW-NP
		b. but did Rebecca save the manual for the oven, or the receipt for the microwave?	WIDE-NP
		c. but did Rebecca save the manual for the oven, or download the receipt for the microwave?	VP
		d. but did Rebecca save the manual for the oven?	BROAD
	Target:	I think Rebecca said she saved the manual for the oven, but I'm not sure.	
50	Context:	I wonder who made such a mess in the kitchen...	
		a. Did Kamala fry steak in the pan, or the pot?	NARROW-NP
		b. Did Kamala fry steak in the pan, or chicken in the pot?	WIDE-NP
		c. Did Kamala fry steak in the pan, or boil chicken in the pot?	VP
		d. Did Kamala fry steak in the pan?	BROAD
	Target:	I think Kamala said she fried steak in the pan, but I could be wrong.	
51	Context:	What happened to Jorge yesterday...	
		a. Did he run into a hive of bees, or wasps	NARROW-NP
		b. Did he run into a hive of bees, or a nest of wasps	WIDE-NP
		c. Did he run into a hive of bees, or walk into a nest of wasps	VP
		d. Did he run into a hive of bees	BROAD
	Target:	I think Jorge said he ran into a hive of bees, but maybe I'm wrong.	
52	Context:	Aron did some repairs around the house yesterday, but I forget...	
		a. did he replace the knob on the door, or the window?	NARROW-NP
		b. did he replace the knob on the door, or the handle on the window?	WIDE-NP
		c. did he replace the knob on the door, or fix the handle on the window?	VP
		d. did he replace the knob on the door?	BROAD
	Target:	I think Aron said he replaced the knob on the door, though I could be wrong.	
53	Context:	For his son's birthday, ...	
		a. did Jean-Sebastien buy a pair of headphones, or speakers?	NARROW-NP
		b. did Jean-Sebastien buy a pair of headphones, or a set of speakers?	WIDE-NP
		c. did Jean-Sebastien buy a pair of headphones, or rent a set of speakers?	VP
		d. did Jean-Sebastien buy a pair of headphones?	BROAD
	Target:	I think Jean-Sebastien said he bought a pair of headphones, but I'm not entirely sure.	

54	Context:	What happened on your camping trip the other day...	
	a.	Did Mikaela scare off a family of raccoons, or possums	NARROW-NP
	b.	Did Mikaela scare off a family of raccoons, or a group of possums	WIDE-NP
	c.	Did Mikaela scare off a family of raccoons, or run from a group of possums	VP
	d.	Did Mikaela scare off a family of raccoons	BROAD
	Target:	I think Mikaela said she scared off a family of raccoons, but I might be forgetting something.	
55	Context:	Haruki has been very busy the last few days...	
	a.	Did he organize a conference for archeologists, or anthropologists?	NARROW-NP
	b.	Did he organize a conference for archeologists, or a workshop for anthropologists?	WIDE-NP
	c.	Did he organize a conference for archeologists, or attend a workshop for anthropologists?	VP
	d.	Did he organize a conference for archeologists?	BROAD
	Target:	I think Haruki said he organized a conference for archeologists, but I'm not sure.	
56	Context:	I wonder why there is a stain on the rug...	
	a.	Did Will drop a mug with coffee, or tea?	NARROW-NP
	b.	Did Will drop a mug with coffee, or a cup of tea?	WIDE-NP
	c.	Did Will drop a mug with coffee, or knock over a cup of tea?	VP
	d.	Did Will drop a mug with coffee?	BROAD
	Target:	I think Will said he dropped a mug with coffee, but I could be wrong.	
57	Context:	I wonder why the kitchen counter is so sticky...	
	a.	Did Timothy spill a jar of honey, or syrup?	NARROW-NP
	b.	Did Timothy spill a jar of honey, or a bottle of syrup?	WIDE-NP
	c.	Did Timothy spill a jar of honey, or shatter a bottle of syrup?	VP
	d.	Did Timothy spill a jar of honey?	BROAD
	Target:	I think Timothy said he spilt a jar of honey, but maybe I'm wrong.	
58	Context:	What exactly happened yesterday...	
	a.	Did Cindy follow the women wearing skis, or skates	NARROW-NP
	b.	Did Cindy follow the women wearing skis, or the children wearing skates	WIDE-NP
	c.	Did Cindy follow the women wearing skis, or escort the children wearing skates	VP
	d.	Did Cindy follow the women wearing skis	BROAD
	Target:	I think Cindy said she followed the women wearing skis, though I could be wrong.	

59	<p>Context: I'm not really up-to-date on what our friends are saying on social media...</p> <p>a. Did Joe tweet about his problems with his glasses, or contacts? NARROW-NP</p> <p>b. Did Joe tweet about his problems with his glasses, or his preference for contacts? WIDE-NP</p> <p>c. Did Joe tweet about his problems with his glasses, or blog about his preference for contacts? VP</p> <p>d. Did Joe tweet about his problems with his glasses? BROAD</p> <p>Target: I think Joe said he tweeted about his problems with his glasses, but I'm not entirely sure.</p>
60	<p>Context: All of my plants died while I was on vacation...</p> <p>a. Did Carol water the flower of the succulent, or the cactus? NARROW-NP</p> <p>b. Did Carol water the flower of the succulent, or the roots of the cactus? WIDE-NP</p> <p>c. Did Carol water the flower of the succulent, or cut off the roots of the cactus? VP</p> <p>d. Did Carol water the flower of the succulent? BROAD</p> <p>Target: I think Carol said she watered the flower of the succulent, but I might be forgetting something.</p>

B.4 Materials for Experiments 6 and 7

1	<p>Context: Last month, Eric wrote a recipe for a pie and muffins, and Nicole wrote a recipe for cupcakes. NEW-NARROW</p> <p>Last month, Eric wrote a review of a pie and a blog about muffins, and Nicole wrote a review of cupcakes. NEW-WIDE</p> <p>Last month, Eric wrote a recipe for a pie and muffins, and Nicole only wrote a recipe for a cake. SO-NARROW</p> <p>Last month, Eric wrote a review of a pie and a blog about muffins, and Nicole only wrote a recipe for a cake. SO-WIDE</p> <p>Target: And/No, Alice only wrote a recipe for a cake, as far as I know.</p>
2	<p>Context: To prepare for the dinner, Fatima ordered two pounds of rice and potatoes, and Alex ordered two pounds of noodles. NEW-NARROW</p> <p>To prepare for the dinner, Fatima ordered a small bag of rice and a bunch of potatoes, and Alex ordered a small bag of noodles. NEW-WIDE</p> <p>To prepare for the dinner, Fatima ordered two pounds of rice and potatoes, and Alex only ordered two pounds of pasta. SO-NARROW</p>

		To prepare for the dinner, Fatima ordered a small bag of rice and a bunch of potatoes, and Alex only ordered two pounds of pasta.	SO-WIDE
	Target:	And/No, Bobby only ordered two pounds of pasta, as far as I can tell.	
3	Context:	Yesterday, Lyn replaced some cables for the laptop and the tv, and Sam replaced some cables for the router.	NEW-NARROW
		Yesterday, Lyn replaced some buttons on the laptop and an adapter for the tv, and Sam replaced some buttons on the router.	NEW-WIDE
		Yesterday, Lyn replaced some cables for the laptop and the tv, and Sam only replaced some cables for the desktop.	SO-NARROW
		Yesterday, Lyn replaced some buttons on the laptop and an adapter for the tv, and Sam only replaced some cables for the desktop.	SO-WIDE
	Target:	And/No, Charles only replaced some cables for the desktop, I think.	
4	Context:	Because he needed some more space in his garage, Dean built a shed for his dryer and his freezer, and Michael built a shed for his fridge.	NEW-NARROW
		Because he needed some more space in his garage, Dean built a cabinet for his dryer and a room for his freezer, and Michael built a cabinet for his fridge.	NEW-WIDE
		Because he needed some more space in his garage, Dean built a shed for his dryer and his freezer, and Michael only built a shed for his washing machine.	SO-NARROW
		Because he needed some more space in his garage, Dean built a cabinet for his dryer and a room for his freezer, and Michael only built a shed for his washing machine.	SO-WIDE
	Target:	And/No, Sebastian only built a shed for his washing machine, it seems to me.	
5	Context:	The Wallace siblings all work in the entertainment industry: Hannah directed a movie about death and love, and Kevin directed a movie about friendship.	NEW-NARROW
		The Wallace siblings all work in the entertainment industry: Hannah directed a play about death and a tv show about love, and Kevin directed a play about friendship.	NEW-WIDE
		The Wallace siblings all work in the entertainment industry: Hannah directed a movie about death and love, and Kevin only directed a movie about birth.	SO-NARROW
		The Wallace siblings all work in the entertainment industry: Hannah directed a play about death and a tv show about love, and Kevin only directed a movie about birth.	SO-WIDE

	Target:	And/No, Emilio only directed a movie about birth, if I remember correctly.	
6	Context:	At the party yesterday, Vic recommended a documentary about sharks and whales, and Amanda recommended a documentary about penguins.	NEW-NARROW
		At the party yesterday, Vic recommended a podcast about sharks and an article about whales, and Amanda recommended a podcast about penguins.	NEW-WIDE
		At the party yesterday, Vic recommended a documentary about sharks and whales, and Amanda only recommended a documentary about dolphins.	SO-NARROW
		At the party yesterday, Vic recommended a podcast about sharks and an article about whales, and Amanda only recommended a documentary about dolphins.	SO-WIDE
	Target:	And/No, Fernanda only recommended a documentary about dolphins, I think.	
7	Context:	At the pet store, George picked up some extra food for the cats and the rabbits, and Sadie picked up some extra food for the guinea pigs.	NEW-NARROW
		At the pet store, George picked up some new toys for the cats and medication for the rabbits, and Sadie picked up some new toys for the guinea pigs.	NEW-WIDE
		At the pet store, George picked up some extra food for the cats and the rabbits, and Sadie only picked up some extra food for the dogs.	SO-NARROW
		At the pet store, George picked up some new toys for the cats and medication for the rabbits, and Sadie only picked up some extra food for the dogs.	SO-WIDE
	Target:	And/No, Judith only picked up some extra food for the dogs, as far as I know.	
8	Context:	Before heading over to the picnic, Holden got some cans of beer and soda, and Nina got some cans of seltzer.	NEW-NARROW
		Before heading over to the picnic, Holden got some bottles of beer and a box of soda, and Nina got some bottles of seltzer.	NEW-WIDE
		Before heading over to the picnic, Holden got some cans of beer and soda, and Nina only got some cans of cider.	SO-NARROW
		Before heading over to the picnic, Holden got some bottles of beer and a box of soda, and Nina only got some cans of cider.	SO-WIDE
	Target:	And/No, Cheyenne only got some cans of cider, as far as I can tell.	

9	<p>Context: Yesterday, Seth received a package with an invitation and a postcard, and Donna received a package with a receipt. Yesterday, Seth received an envelope with an invitation and voicemail about a postcard, and Donna received an envelope with a receipt. Yesterday, Seth received a package with an invitation and a postcard, and Donna only received a package with a letter. Yesterday, Seth received an envelope with an invitation and voicemail about a postcard, and Donna only received a package with a letter.</p> <p>Target: And/No, Irene only received a package with a letter, I think.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>
10	<p>Context: The kids made a mess this morning: Jacob spilled yogurt on the wall and on the counter, and Valeria spilled yogurt on the table. The kids made a mess this morning: Jacob spilled cottage cheese on the wall and milk on the counter, and Valeria spilled cottage cheese on the table. The kids made a mess this morning: Jacob spilled yogurt on the wall and on the counter, and Valeria only spilled yogurt on the floor. The kids made a mess this morning: Jacob spilled cottage cheese on the wall and milk on the counter, and Valeria only spilled yogurt on the floor.</p> <p>Target: And/No, Laura only spilled yogurt on the floor, it seems to me.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>
11	<p>Context: Back in the day, Alexander owned a parking spot for his van and his truck, and Martin owned a parking spot for his convertible. Back in the day, Alexander owned a garage for his van and a canopy for his truck, and Martin owned a garage for his convertible. Back in the day, Alexander owned a parking spot for his van and his truck, and Martin only owned a parking spot for his car. Back in the day, Alexander owned a garage for his van and a canopy for his truck, and Martin only owned a parking spot for his car.</p> <p>Target: And/No, Kenji only owned a parking spot for his car, if I remember correctly.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>

12	Context:	My friends are all really nerdy: Lucy oversees art for comics and video games, and Ben oversees art for card games.	NEW-NARROW
		My friends are all really nerdy: Lucy oversees narratives for comics and sound effects in video games, and Ben oversees narratives for card games.	NEW-WIDE
		My friends are all really nerdy: Lucy oversees art for comics and video games, and Ben only oversees art for board games.	SO-NARROW
		My friends are all really nerdy: Lucy oversees narratives for comics and sound effects in video games, and Ben only oversees art for board games.	SO-WIDE
	Target:	And/No, Jayden-Lee only oversees art for board games, I think.	
13	Context:	At the coffee shop, Aaron wanted to have tea with biscuits and cupcakes, and Jenna wanted to have tea with scones.	NEW-NARROW
		At the coffee shop, Aaron wanted to have coffee with biscuits and milk with cupcakes, and Jenna wanted to have coffee with scones.	NEW-WIDE
		At the coffee shop, Aaron wanted to have tea with biscuits and cupcakes, and Jenna only wanted to have tea with chocolate.	SO-NARROW
		At the coffee shop, Aaron wanted to have coffee with biscuits and milk with cupcakes, and Jenna only wanted to have tea with chocolate.	SO-WIDE
	Target:	And/No, Maddy only wanted to have tea with chocolate, as far as I know.	
14	Context:	Everyone was working hard on their sewing projects: Netta sewed the front of a sweater and a shirt, and Jorge sewed the front of pair of jeans.	NEW-NARROW
		Everyone was working hard on their sewing projects: Netta sewed the back of a sweater and the pocket of a shirt, and Jorge sewed the back of pair of jeans.	NEW-WIDE
		Everyone was working hard on their sewing projects: Netta sewed the front of a sweater and a shirt, and Jorge only sewed the front of a jacket.	SO-NARROW
		Everyone was working hard on their sewing projects: Netta sewed the back of a sweater and the pocket of a shirt, and Jorge only sewed the front of a jacket.	SO-WIDE
	Target:	And/No, Nick only sewed the front of a jacket, as far as I can tell.	

15	Context:	No one really eats nuts in this family, because Stella has an allergy to cashews and hazelnuts, and Paola has an allergy to almonds.	NEW-NARROW
		No one really eats nuts in this family, because Stella has an intolerance for cashews and a distaste for hazelnuts, and Paola has an intolerance for almonds.	NEW-WIDE
		No one really eats nuts in this family, because Stella has an allergy to cashews and hazelnuts, and Paola only has an allergy to peanuts.	SO-NARROW
		No one really eats nuts in this family, because Stella has an intolerance for cashews and a distaste for hazelnuts, and Paola only has an allergy to peanuts.	SO-WIDE
	Target:	And/No, Oliver only has an allergy to peanuts, I think.	
16	Context:	At IKEA, Pete sat on a chair made of leather and plastic, and Maribel sat on a chair made of wood.	NEW-NARROW
		At IKEA, Pete sat on a sofa made of leather and a bench made out of plastic, and Maribel sat on a sofa made of wood.	NEW-WIDE
		At IKEA, Pete sat on a chair made of leather and plastic, and Maribel only sat on a chair made of cotton.	SO-NARROW
		At IKEA, Pete sat on a sofa made of leather and a bench made out of plastic, and Maribel only sat on a chair made of cotton.	SO-WIDE
	Target:	And/No, Jocelyn only sat on a chair made of cotton, it seems to me.	
17	Context:	My friends are all famous! Yasmin got quoted in an article in a magazine and a podcast, and Joe got quoted in an article in a documentary series.	NEW-NARROW
		My friends are all famous! Yasmin got quoted in a feature in a magazine and an episode of a podcast, and Joe got quoted in a feature in a documentary series.	NEW-WIDE
		My friends are all famous! Yasmin got quoted in an article in a magazine and a podcast, and Joe only got quoted in an article in a newspaper.	SO-NARROW
		My friends are all famous! Yasmin got quoted in a feature in a magazine and an episode of a podcast, and Joe only got quoted in an article in a newspaper.	SO-WIDE
	Target:	And/No, Rick only got quoted in an article in a newspaper, if I remember correctly.	

18	<p>Context: Many things went wrong today: Andy added an extra tablespoon of pepper and flour, and Emily added an extra tablespoon of baking soda.</p> <p>Many things went wrong today: Andy added an extra teaspoon of pepper and cup of flour, and Emily added an extra teaspoon of baking soda.</p> <p>Many things went wrong today: Andy added an extra tablespoon of pepper and flour, and Emily only added an extra tablespoon of salt.</p> <p>Many things went wrong today: Andy added an extra teaspoon of pepper and cup of flour, and Emily only added an extra tablespoon of salt.</p> <p>Target: And/No, Susan only added an extra tablespoon of salt, I think.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>
19	<p>Context: My sons all worked hard this weekend. Steven devoted himself to a lab for chemistry and physics, and Matthew devoted himself to a lab for math.</p> <p>My sons all worked hard this weekend. Steven devoted himself to a textbook on chemistry and an assignment for physics, and Matthew devoted himself to a textbook on math.</p> <p>My sons all worked hard this weekend. Steven devoted himself to a lab for chemistry and physics, and Matthew only devoted himself to a lab for biology.</p> <p>My sons all worked hard this weekend. Steven devoted himself to a textbook on chemistry and an assignment for physics, and Matthew only devoted himself to a lab for biology.</p> <p>Target: And/No, Matthew only devoted himself to a lab for biology, as far as I know.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>
20	<p>Context: My friends all brought some people to the party. Daniel came with a friend of his sister and his boss, and Zac came with a friend of his roommate.</p> <p>My friends all brought some people to the party. Daniel came with a colleague of his sister and a cousin of his boss, and Zac came with a colleague of his roommate.</p> <p>My friends all brought some people to the party. Daniel came with a friend of his sister and his boss, and Zac only came with a friend of his mother.</p> <p>My friends all brought some people to the party. Daniel came with a colleague of his sister and a cousin of his boss, and Zac only came with a friend of his mother.</p> <p>Target: And/No, Asher only came with a friend of his mother, as far as I can tell.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>

21	Context:	All the volunteers worked hard yesterday. Isabel made a stable for the horses and the sheep, and Logan made a stable for the goats.	NEW-NARROW
		All the volunteers worked hard yesterday. Isabel made a water trough for the horses and a feeder for the sheep, and Logan made a water trough for the goats.	NEW-WIDE
		All the volunteers worked hard yesterday. Isabel made a stable for the horses and the sheep, and Logan only made a stable for the cows.	SO-NARROW
		All the volunteers worked hard yesterday. Isabel made a water trough for the horses and a feeder for the sheep, and Logan only made a stable for the cows.	SO-WIDE
	Target:	And/No, Wesley only made a stable for the cows, it seems to me.	
22	Context:	Yesterday, Ian cancelled a lunch with his daughter and his doctor, and Pamela cancelled a lunch with his coach.	NEW-NARROW
		Yesterday, Ian cancelled a dinner with his daughter and an appointment with his doctor, and Pamela cancelled a dinner with his coach.	NEW-WIDE
		Yesterday, Ian cancelled a lunch with his daughter and his doctor, and Pamela only cancelled a lunch with her wife.	SO-NARROW
		Yesterday, Ian cancelled a dinner with his daughter and an appointment with his doctor, and Pamela only cancelled a lunch with her wife.	SO-WIDE
	Target:	And/No, Yael only cancelled a lunch with her wife, if I remember correctly.	
23	Context:	As a Christmas present, Chris gave a scarf to his mother and to his sister, and Stevie gave a scarf to his grandma.	NEW-NARROW
		As a Christmas present, Chris gave a hat to his mother and mittens to his sister, and Stevie gave a hat to his grandma.	NEW-WIDE
		As a Christmas present, Chris gave a scarf to his mother and to his sister, and Stevie only gave a scarf to his nephew.	SO-NARROW
		As a Christmas present, Chris gave a hat to his mother and mittens to his sister, and Stevie only gave a scarf to his nephew.	SO-WIDE
	Target:	And/No, Zack only gave a scarf to his nephew, I think.	

24	Context:	This morning, Patricia sketched a schema of a tunnel and a new building, and James sketched a schema of a parking garage.	NEW-NARROW
		This morning, Patricia sketched a picture of a tunnel and a plan for a new building, and James sketched a picture of a parking garage.	NEW-WIDE
		This morning, Patricia sketched a schema of a tunnel and a new building, and James only sketched a schema of a bridge.	SO-NARROW
		This morning, Patricia sketched a picture of a tunnel and a plan for a new building, and James only sketched a schema of a bridge.	SO-WIDE
	Target:	And/No, Aiden only sketched a schema of a bridge, as far as I know.	
25	Context:	My friends like to gossip. Amanda sent a screenshot to her uncle and her cousin, and Alessa sent a screenshot to her lover.	NEW-NARROW
		My friends like to gossip. Amanda sent an email about her uncle and a picture of her cousin, and Alessa sent an email about her lover.	NEW-WIDE
		My friends like to gossip. Amanda sent a screenshot to her uncle and her cousin, and Alessa only sent a screenshot to her aunt.	SO-NARROW
		My friends like to gossip. Amanda sent an email about her uncle and a picture of her cousin, and Alessa only sent a screenshot to her aunt.	SO-WIDE
	Target:	And/No, Bethany only sent a screenshot to her aunt, as far as I can tell.	
26	Context:	This weekend, Carla got a giftcard for her wedding and her anniversary, and Monica got a giftcard for her graduation.	NEW-NARROW
		This weekend, Carla got money for her wedding and a bouquet for her anniversary, and Monica got money for her graduation.	NEW-WIDE
		This weekend, Carla got a giftcard for her wedding and her anniversary, and Monica only got a giftcard for her birthday.	SO-NARROW
		This weekend, Carla got money for her wedding and a bouquet for her anniversary, and Monica only got a giftcard for her birthday.	SO-WIDE
	Target:	And/No, Nadia only got a giftcard for her birthday, I think.	

27	Context:	Lots of things went wrong today. David crashed into the corner of a tram and a van, and Phoebe crashed into the corner of a truck.	NEW-NARROW
		Lots of things went wrong today. David crashed into the side of a tram and the front of a van, and Phoebe crashed into the side of a truck.	NEW-WIDE
		Lots of things went wrong today. David crashed into the corner of a tram and a van, and Phoebe only crashed into the corner of a bus.	SO-NARROW
		Lots of things went wrong today. David crashed into the side of a tram and the front of a van, and Phoebe only crashed into the corner of a bus.	SO-WIDE
	Target:	And/No, Mathilda only crashed into the corner of a bus, it seems to me.	
28	Context:	At the clothing store, Eli bought a onesie for a toddler and a small child, and Rachel bought a onesie for a teenager.	NEW-NARROW
		At the clothing store, Eli bought a blanket for a toddler and a jacket for a small child, and Rachel bought a blanket for a teenager.	NEW-WIDE
		At the clothing store, Eli bought a onesie for a toddler and a small child, and Rachel only bought a onesie for a baby.	SO-NARROW
		At the clothing store, Eli bought a blanket for a toddler and a jacket for a small child, and Rachel only bought a onesie for a baby.	SO-WIDE
	Target:	And/No, Sophia only bought a onesie for a baby, if I remember correctly.	
29	Context:	During the summer, Sarah painted the doors in the kitchen and the office, and Vishal painted the doors in the bedroom.	NEW-NARROW
		During the summer, Sarah painted the window frames in the kitchen and the floor in the office, and Vishal painted the window frames in the bedroom.	NEW-WIDE
		During the summer, Sarah painted the doors in the kitchen and the office, and Vishal only painted the doors in the living room.	SO-NARROW
		During the summer, Sarah painted the window frames in the kitchen and the floor in the office, and Vishal only painted the doors in the living room.	SO-WIDE
	Target:	And/No, Finneas only painted the doors in the living room, I think.	

30	Context:	The employees worked hard today. Vinny edited a paper about inflation and the pandemic, and Karen edited a paper about mental health.	NEW-NARROW
		The employees worked hard today. Vinny edited a report about inflation and an article about the pandemic, and Karen edited a report about mental health.	NEW-WIDE
		The employees worked hard today. Vinny edited a paper about inflation and the pandemic, and Karen only edited a paper about climate change.	SO-NARROW
		The employees worked hard today. Vinny edited a report about inflation and an article about the pandemic, and Karen only edited a paper about climate change.	SO-WIDE
	Target:	And/No, Hailey only edited a paper about climate change, as far as I can tell.	
31	Context:	My friends are all quite well off. John rents a house with a garden and a balcony, and Sally rents a house with a shared patio.	NEW-NARROW
		My friends are all quite well off. John rents an apartment with a garden and a studio with a balcony, and Sally rents an apartment with a shared patio.	NEW-WIDE
		My friends are all quite well off. John rents a house with a garden and a balcony, and Sally only rents a house with a garage.	SO-NARROW
		My friends are all quite well off. John rents an apartment with a garden and a studio with a balcony, and Sally only rents a house with a garage.	SO-WIDE
	Target:	And/No, Ivy only rents a house with a garage, I think.	
32	Context:	Last semester, Richard organized a conference for anthropologists and historians, and Angelica organized a conference for sociologists.	NEW-NARROW
		Last semester, Richard organized a workshop for anthropologists and a networking event for historians, and Angelica organized a workshop for sociologists.	NEW-WIDE
		Last semester, Richard organized a conference for anthropologists and historians, and Angelica only organized a conference for archeologists.	SO-NARROW
		Last semester, Richard organized a workshop for anthropologists and a networking event for historians, and Angelica only organized a conference for archeologists.	SO-WIDE
	Target:	And/No, Katie only organized a conference for archeologists, if I remember correctly.	

33	<p>Context: While cleaning the bathroom, Anna scrubbed the inside of the sink and the bathtub, and Chris scrubbed the inside of the shower.</p> <p>While cleaning the bathroom, Anna scrubbed the surface of the sink and the outside the bathtub, and Chris scrubbed the surface of the shower.</p> <p>While cleaning the bathroom, Anna scrubbed the inside of the sink and the bathtub, and Chris only scrubbed the inside of the toilet.</p> <p>While cleaning the bathroom, Anna scrubbed the surface of the sink and the outside the bathtub, and Chris only scrubbed the inside of the toilet.</p> <p>Target: And/No, Lucas only scrubbed the inside of the toilet, I think.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>
34	<p>Context: During the networking event, Molly talked to the brother of an accountant and a CEO, and Frank talked to the brother of a surgeon.</p> <p>During the networking event, Molly talked to the daughter of an accountant and the son of a CEO, and Frank talked to the daughter of a surgeon.</p> <p>During the networking event, Molly talked to the brother of an accountant and a CEO, and Frank only talked to the brother of a lawyer.</p> <p>During the networking event, Molly talked to the daughter of an accountant and the son of a CEO, and Frank only talked to the brother of a lawyer.</p> <p>Target: And/No, Jack only talked to the brother of a lawyer, as far as I know.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>
35	<p>Context: In preparation for the dinner, Andrew sliced a pound of cucumbers and onions, and Mariana sliced a pound of garlic.</p> <p>In preparation for the dinner, Andrew sliced half a pound of cucumbers and three cups of onions, and Mariana sliced half a pound of garlic.</p> <p>In preparation for the dinner, Andrew sliced a pound of cucumbers and onions, and Mariana only sliced a pound of tomatoes.</p> <p>In preparation for the dinner, Andrew sliced half a pound of cucumbers and three cups of onions, and Mariana only sliced a pound of tomatoes.</p> <p>Target: And/No, Norah only sliced a pound of tomatoes, as far as I can tell.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>

36	Context:	Herbs are really popular these days. Omar bought some cilantro at the farmer's market and at the garden store, and Julia bought some cilantro on the internet.	NEW-NARROW
		Herbs are really popular these days. Omar bought some parsley at the farmer's market and some basil at the garden store, and Julia bought some parsley on the internet.	NEW-WIDE
		Herbs are really popular these days. Omar bought some cilantro at the farmer's market and at the garden store, and Julia only bought some cilantro at the supermarket.	SO-NARROW
		Herbs are really popular these days. Omar bought some parsley at the farmer's market and some basil at the garden store, and Julia only bought some cilantro at the supermarket.	SO-WIDE
	Target:	And/No, Nikki only bought some cilantro at the supermarket, I think.	
37	Context:	While cleaning the house, Owen dusted the cabinet in the bedroom and the office, and Delaney dusted the cabinet in the hallway.	NEW-NARROW
		While cleaning the house, Owen dusted the closet in the bedroom and the floor in the office, and Delaney dusted the closet in the hallway.	NEW-WIDE
		While cleaning the house, Owen dusted the cabinet in the bedroom and the office, and Delaney only dusted the cabinet in the bathroom.	SO-NARROW
		While cleaning the house, Owen dusted the closet in the bedroom and the floor in the office, and Delaney only dusted the cabinet in the bathroom.	SO-WIDE
	Target:	And/No, Paige only dusted the cabinet in the bathroom, it seems to me.	
38	Context:	At the train station, Ricardo found a bag with keys and a phone, and Martha found a bag with a passport.	NEW-NARROW
		At the train station, Ricardo found a purse with keys and a backpack with a phone, and Martha found a purse with a passport.	NEW-WIDE
		At the train station, Ricardo found a bag with keys and a phone, and Martha only found a bag with a wallet.	SO-NARROW
		At the train station, Ricardo found a purse with keys and a backpack with a phone, and Martha only found a bag with a wallet.	SO-WIDE
	Target:	And/No, Janice only found a bag with a wallet, if I remember correctly.	

39	Context:	Last year, Sienna photographed some raccoons in the backyard and in the alleyway, and Paul photographed some raccoons in the parking lot.	NEW-NARROW
		Last year, Sienna photographed some possums in the backyard and some coyotes in the alleyway, and Paul photographed some possums in the parking lot.	NEW-WIDE
		Last year, Sienna photographed some raccoons in the backyard and in the alleyway, and Paul only photographed some raccoons in the forest.	SO-NARROW
		Last year, Sienna photographed some possums in the backyard and some coyotes in the alleyway, and Paul only photographed some raccoons in the forest.	SO-WIDE
	Target:	And/No, Benjamin only photographed some raccoons in the forest, I think.	
40	Context:	This winter, Tom met up with family for Christmas and for Thanksgiving, and Sonya met up with family for Easter.	NEW-NARROW
		This winter, Tom met up with friends for Christmas and colleagues for Thanksgiving, and Sonya met up with friends for Easter.	NEW-WIDE
		This winter, Tom met up with family for Christmas and for Thanksgiving, and Sonya only met up with family for Memorial day.	SO-NARROW
		This winter, Tom met up with friends for Christmas and colleagues for Thanksgiving, and Sonya only met up with family for Memorial day.	SO-WIDE
	Target:	And/No, Leyla only met up with family for Memorial Day as far as I know.	
41	Context:	At the restaurant, Maxwell asked for an entree with cardamom and eggplant, and Kara asked for an entree with mushrooms.	NEW-NARROW
		At the restaurant, Maxwell asked for a dessert with cardamom and a starter with eggplant, and Kara asked for a dessert with mushrooms.	NEW-WIDE
		At the restaurant, Maxwell asked for an entree with cardamom and eggplant, and Kara only asked for an entree with lamb.	SO-NARROW
		At the restaurant, Maxwell asked for a dessert with cardamom and a starter with eggplant, and Kara only asked for an entree with lamb.	SO-WIDE
	Target:	And/No, Willow only asked for an entree with lamb, I think.	

42	Context:	While doing some repairs this weekend, Zach fixed the knob on the window and the cabinet, and Ashley fixed the knob on the back door.	NEW-NARROW
		While doing some repairs this weekend, Zach fixed the lock on the window and the hinges on the cabinet, and Ashley fixed the lock on the back door.	NEW-WIDE
		While doing some repairs this weekend, Zach fixed the knob on the window and the cabinet, and Ashley only fixed the knob on the front door.	SO-NARROW
		While doing some repairs this weekend, Zach fixed the lock on the window and the hinges on the cabinet, and Ashley only fixed the knob on the front door.	SO-WIDE
	Target:	And/No, Maria only fixed the knob on the front door, it seems to me.	
43	Context:	All the people in this elderly care facility are active on Twitter. Yesterday, Ryan tweeted about his problems with his knee surgery and his hearing aid, and Bill tweeted about his problems with his pacemaker.	NEW-NARROW
		All the people in this elderly care facility are active on Twitter. Yesterday, Ryan tweeted about his gratitude for his knee surgery and his experience with his hearing aid, and Bill tweeted about his gratitude for his pacemaker.	NEW-WIDE
		All the people in this elderly care facility are active on Twitter. Yesterday, Ryan tweeted about his problems with his knee surgery and his hearing aid, and Bill only tweeted about his problems with his glasses.	SO-NARROW
		All the people in this elderly care facility are active on Twitter. Yesterday, Ryan tweeted about his gratitude for his knee surgery and his experience with his hearing aid, and Bill only tweeted about his problems with his glasses.	SO-WIDE
	Target:	And/No, John only tweeted about his problems with his glasses, if I remember correctly.	
44	Context:	This morning, Bob cut off the flower of the cactus and the orchid, and Melissa cut off the flower of the geranium.	NEW-NARROW
		This morning, Bob cut off the roots of the cactus and the stem of the orchid, and Melissa cut off the roots of the geranium.	NEW-WIDE
		This morning, Bob cut off the flower of the cactus and the orchid, and Melissa only cut off the flower of the succulent.	SO-NARROW
		This morning, Bob cut off the roots of the cactus and the stem of the orchid, and Melissa only cut off the flower of the succulent.	SO-WIDE
	Target:	And/No, Christina only cut off the flower of the succulent, I think.	

45	Context:	Everything was very chaotic this week. Chloe ran late for her soccer practice on Wednesday and Saturday, and Jessie ran late for her soccer practice on Monday.	NEW-NARROW
		Everything was very chaotic this week. Chloe ran late for her piano lesson on Wednesday and her tutoring session on Saturday, and Jessie ran late for her piano lesson on Monday.	NEW-WIDE
		Everything was very chaotic this week. Chloe ran late for her soccer practice on Wednesday and Saturday, and Jessie only ran late for her soccer practice on Tuesday.	SO-NARROW
		Everything was very chaotic this week. Chloe ran late for her piano lesson on Wednesday and her tutoring session on Saturday, and Jessie only ran late for her soccer practice on Tuesday.	SO-WIDE
	Target:	And/No, Alex only ran late for her soccer practice on Tuesday, as far as I know.	
46	Context:	At the bar, Cecile fancied the tall guy with the jeans and the glasses, and Leon fancied the tall guy with the beanie.	NEW-NARROW
		At the bar, Cecile fancied the short guy with the jeans and the bartender with the glasses, and Leon fancied the short guy with the beanie.	NEW-WIDE
		At the bar, Cecile fancied the tall guy with the jeans and the glasses, and Leon only fancied the tall guy with the shorts.	SO-NARROW
		At the bar, Cecile fancied the short guy with the jeans and the bartender with the glasses, and Leon only fancied the tall guy with the shorts.	SO-WIDE
	Target:	And/No, Jeremy only fancied the tall guy with the shorts, as far as I can tell.	
47	Context:	My family always keeps stuff they don't need. Ken saved the manual for the microwave and the food processor, and Alicia saved the manual for the airfryer.	NEW-NARROW
		My family always keeps stuff they don't need. Ken saved the receipt for the microwave and the advertisement for the food processor, and Alicia saved the receipt for the airfryer.	NEW-WIDE
		My family always keeps stuff they don't need. Ken saved the manual for the microwave and the food processor, and Alicia only saved the manual for the oven.	SO-NARROW
		My family always keeps stuff they don't need. Ken saved the receipt for the microwave and the advertisement for the food processor, and Alicia only saved the manual for the oven.	SO-WIDE
	Target:	And/No, Hannah only saved the manual for the oven, I think.	

48	<p>Context: My kids are avid readers. Jimmy read a book about penguins and whales, and Catherine read a book about gorillas.</p> <p>My kids are avid readers. Jimmy read an article about penguins and a report about whales, and Catherine read an article about gorillas.</p> <p>My kids are avid readers. Jimmy read a book about penguins and whales, and Catherine only read a book about bats.</p> <p>My kids are avid readers. Jimmy read an article about penguins and a report about whales, and Catherine only read a book about bats.</p> <p>Target: And/No, Ashley only read a book about bats, if I'm not mistaken.</p>	<p>NEW-NARROW</p> <p>NEW-WIDE</p> <p>SO-NARROW</p> <p>SO-WIDE</p>
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B.5 Materials for Experiments 8-10

Materials in the assoc non-excl condition

- | | |
|---|---|
| 1 | <p>Context: The tourist had asked for a variety of items, such as cheese and some yogurt. There was already an ashtray on the table.</p> <p>Target: When the waiter returned, he remembered to bring only some yogurt but no cheese to the table.</p> |
| 2 | <p>Context: At the bar yesterday, John had ordered some wine and some beer. He didn't order any nuts the whole evening.</p> <p>Target: All of a sudden, he had to leave quickly and he finished only his beer but not his wine when he stood up.</p> |
| 3 | <p>Context: This weekend I made a few phone calls, including to my uncle and to my aunt. I couldn't call my bank until next week.</p> <p>Target: I got a call back only from my aunt but not from my uncle, before the end of the weekend.</p> |
| 4 | <p>Context: Erin's neighbor has all kinds of interesting objects, such as an antique violin and a piano. She was hoping to get some clocks at some point in the future.</p> <p>Target: She showed Erin only a piano but not a violin, while Erin was at her house.</p> |
| 5 | <p>Context: Ben loves to help out on his uncle's farm, for example by taking care of the ponies and the horses. His uncle doesn't keep any ducks at the farm anymore.</p> <p>Target: This summer, Ben's uncle will keep raising only some horses but no ponies, even though Ben liked them very much.</p> |
| 6 | <p>Context: The corner store sells a bunch of things, such as magazines and newspapers. They never sold any cigarettes.</p> <p>Target: Last summer, they only stopped selling newspapers but not magazines due to supply chain issues.</p> |
| 7 | <p>Context: The city council had big plans to improve the neighborhood, including the construction of a bus station and a metro station. A few years ago, they had already built a swimming pool.</p> <p>Target: It will be difficult to get construction permits, but only for a metro station, not for a bus station, until they meet with the mayor.</p> |

- 8 **Context:** In the cabinet underneath the sink, Stephanie stored various things, like a hammer and a screwdriver. She didn't keep her soap there.
Target: While cleaning out the cabinet, she threw away only her screwdriver but not her hammer because she wanted to use it later.
- 9 **Context:** The stylist added some sofas and chairs to the hotel lobby. She decided not to put any flowerpots there.
Target: When the owner saw the results, she noticed only some chairs but no sofas in the corner of the room.
- 10 **Context:** After breaking up with his girlfriend, Peter put her tv and her radio on Craigslist. He decided to keep her bike for himself.
Target: In the end, he managed to sell only her radio but not her tv, because potential buyers were looking for a lower price.
- 11 **Context:** In her first year of college, Monique was very good at biology and chemistry. She had dropped her sports class earlier that year.
Target: After winter break, she kept performing well only in chemistry but not in biology for a while.
- 12 **Context:** At the zoo, they used to have tigers and lions. They did not have the right permits to add some pelicans to their new exhibit.
Target: After animal rights activists discovered how some of the animals were treated, they kept only some lions but no tigers until they improved their living conditions.
- 13 **Context:** Jess went into town to get some new shoes and socks. She was also planning to order some new pencils on Amazon later that week.
Target: The stores were almost empty, and she found only some socks but no shoes before she had to go home.
- 14 **Context:** The artist who has a booth at the local fair sells bracelets made with different materials, like wool and cotton. She has never used metal before.
Target: People bought her bracelets, but only those with cotton, not with wool this time.
- 15 **Context:** Magda still needed some things to finish her new tiny house, such as some windows and a door. She couldn't find any tape anywhere in the store.
Target: At the hardware store, she thought the prices were reasonable, but only of the doors and not of the windows, even though she brought a lot of cash.
- 16 **Context:** The concierge was busy fixing the damages from the storm, including the broken fence and the gate. Luckily, the camera on the other side of the property didn't need any repairs.
Target: He managed to fix only the gate but not the fence before his workday was over.
- 17 **Context:** Isabel had only eyes for her new project, and she ignored important emails and some letters. She did, however, respond to the software updates that came in.
Target: When she finished the project, she finally took care of some things, but only of the letters and not of any emails in her backlog.
- 18 **Context:** Aron was getting some final things for his son's pirate-themed birthday party, like a pie and some cake. Not knowing what his son's friends could handle, he had decided that he wouldn't buy any swords for the party.
Target: It was already late, so he managed to buy only the cake but no pie, before the stores closed.
- 19 **Context:** Brenda was busy packing, and in her suitcase there were some boots and sandals. She completely forgot to pack her toothbrush because she was in such a hurry.
Target: When she was going through security at the airport the next day, they would let her bring only her sandals but not her boots in her hand luggage.

- 20 **Context:** Because that region is extremely remote, there are only a few ways to get there, such as by airplane or by helicopter. There is no way you can reach the area by bus at all.
Target: Jonathan knew how to get there, but he had gone there only by helicopter and not by airplane, even though it takes less time.
- 21 **Context:** Owen and Chris are organizing a big picnic at the park, and they had asked people to bring some tomatoes and some cucumbers. They had already brought a cooler with some beers in it.
Target: Their friends managed to get only some cucumbers but no tomatoes before it started raining.
- 22 **Context:** In his bag, David had packed a few things for the weekend, like jeans and a pair of shorts. He forgot to bring a book on his trip.
Target: By the end of the weekend, he had unpacked only his shorts but not his jeans, because it was unexpectedly warm.
- 23 **Context:** The organizers of the workshop had invited some painters and some sculptors. They deliberately didn't ask a lawyer this time.
Target: A few weeks before the event, they heard back only from a sculptor but not from any painters, even though they had sent a number of emails.
- 24 **Context:** Daniel was planning a deep-clean of his house this weekend, including the stove and the oven. His wife had already cleaned the garage last week.
Target: He managed to clean only the oven but not the stove, before going to bed.
- 25 **Context:** Sophia made a quick run to the grocery store to get some flour and some milk. Dan texted her that she didn't need to bring any sponges from the store.
Target: At the store, she remembered only to buy milk but no flour for some reason.
- 26 **Context:** Lily loves to go to thrift stores, and this Saturday she was hoping to find a sweater or a jacket. Last week she found a great puzzle so she didn't need one of those anymore.
Target: At the store she managed to find only a jacket but not a sweater, to her chagrin.
- 27 **Context:** The photographer made a list of things to bring to the shoot the next day, including an extra charger and some batteries. Her colleague was bringing some snacks so she didn't have to.
Target: The next morning she remembered to bring only some batteries but no charger because it slipped her mind.
- 28 **Context:** This 3-bedroom apartment has a few nice perks. For example, it comes with a large attic and a basement. It doesn't come with a year-long lease, unfortunately.
Target: The advertisement mentioned only the basement but not the attic on the website.
- 29 **Context:** Jim had gone to Ikea to get spoons and some knives. He wanted to go to an antique store later to find a nice bed.
Target: Later, his partner returned only the knives but no spoons, even though they were quite expensive.
- 30 **Context:** Maria wanted to be a hairdresser, and she used to practice on her mother and her sister. Unfortunately, her dog's hair was too brittle for her to work with.
Target: Nowadays, Maria still likes to cut only her sister's hair but not her mother's, for some reason.

- 31 **Context:** At the lost-and-found of the museum, there were a range of things that people had left behind, such as a purse and a bag. There weren't any cameras that had been found recently.
Target: After the museum had made some announcements, people picked up only the bag but no purse, even though the purses looked more expensive.
- 32 **Context:** At the donation center, several volunteers were helping to gather supplies for the homeless, like pillows and blankets. Despite many requests, no one had dropped off any food at the donation center.
Target: At the end of the day, the volunteers were happy only with the blankets but not with any pillows, which was unfortunate.
- 33 **Context:** Most of the people who were at the protest were unionized, like the doctors and the nurses. Unfortunately, none of the carpenters had shown up to the protest.
Target: At the end of the day, only some nurses but no doctor had left the protest.
- 34 **Context:** Lauren told James that there were several things they still needed for the recipe they wanted to make, like some pears and some apples. For allergy reasons, they had decided to leave out the salmon.
Target: At the supermarket, James could find only some apples but no pears, because they were in the wrong aisle.
- 35 **Context:** Nicole went to the pharmacy where she bought a number of things, like soap and shampoo. She forgot to buy the vitamins that her mother had asked her to get.
Target: When she looked at the receipt, it listed only shampoo but not soap to her surprise.
- 36 **Context:** At the organic supermarket, a number of things were on sale this week, including parsley and thyme. The store had been out of candy for a few weeks now.
Target: The store managers noticed that customers bought only some thyme but no parsley even though it was on sale.
- 37 **Context:** Allie's housemates had asked her to bring back a few things for the house, like cherries and strawberries. She couldn't find any toilet paper at the store.
Target: Allie's bag could fit only the strawberries but no cherries on her way home.
- 38 **Context:** Before the contractors came, a lot of decisions still had to be made, like the choice of the sink and the faucet. The house already came with an alarm system when Judith bought it.
Target: Judith managed to choose only a faucet but no sink, before they started building the kitchen.
- 39 **Context:** At the recreation center, you can rent stuff like canoes and kayaks. Camper vans are not available here.
Target: Lately, people continue to rent only the kayaks but no canoes, because of numerous safety concerns.
- 40 **Context:** In her handbag Alex always carries a lot of stuff, such as her lipstick and her eyeshadow. She knew her keys were in her pocket.
Target: After searching for a while, she found only her eyeshadow but not her lipstick in her bag.
- 41 **Context:** At the zoo, there used to be a lot of different kinds of animals, like goats and sheep. There had never been any fish there.
Target: Jason's nephew enjoyed seeing only the sheep but not the goats during his visit to the zoo.
- 42 **Context:** Briana ordered a few things for the table, like pizza and some pasta. She didn't want to order any water.
Target: At the end of the evening, Briana had touched only some of her pasta but no pizza, even though she was very hungry.

- 43 **Context:** The local farmer’s market sells various crafts such as handmade gloves and scarves. As always, the teapots were already sold out before 10am.
Target: When Hannah went there at noon, she liked only some scarves but no gloves at the market.
- 44 **Context:** Along the driveway to the hotel, the gardener had planted some pines and some palms. He had always wanted to plant some tulips but he had never gotten around to it.
Target: After the storm, he trimmed only some palms but no pines on the right side of the driveway
- 45 **Context:** Sabrina was on her way to the hardware store where she wanted to buy a few things like nails and screws. She didn’t need any lightbulbs anymore.
Target: In the end, she managed to buy only some screws but no nails at the store.
- 46 **Context:** After Linda got back to the hostel, she noticed that some of her belongings were gone, like her necklace and her bracelet. Luckily, she saw that her computer was still there.
Target: After searching for hours, she found only her bracelet but not her necklace, abandoned in the dumpster.
- 47 **Context:** It’s really hard to concentrate in this office because there are always lots of sounds, like that of an alarm or a phone. Fortunately, though, you can never hear the wind in this place.
Target: Noise-cancelling headphones cancel out some of the noise, but only of the phones, not of any alarms going off all the time.
- 48 **Context:** Last summer, this neighborhood was under heavy construction because they’re building some new apartments and houses. The existing bridge had to be demolished.
Target: By fall, they had finished building only a few houses but no apartments on time.

B.6 Alternative triplets for Experiments 8-10

	alt1 (target)	alt2 (assoc)	alt3 (non-assoc)	alt1-alt2	alt1-alt3
1	yogurt	cheese	ashtray	0.86	-0.0
2	beer	wine	nuts	0.85	0.07
3	aunt	uncle	bank	0.82	0.01
4	piano	violin	clocks	0.80	0.10
5	horses	ponies	ducks	0.79	0.06
6	newspapers	magazines	cigarettes	0.75	0.06
7	metro station	bus station	swimming pool	0.75	0.11
8	screwdriver	hammer	soap	0.59	0.08
9	chair	sofa	flowerpot	0.73	0.05
10	radio	tv	bike	0.70	0.01
11	chemistry	biology	sports	0.68	0.04
12	lions	tigers	pelicans	0.68	0.08

13	socks	shoes	pencils	0.67	0.09
14	cotton	wool	metal	0.67	0.0
15	doors	windows	tape	0.66	0.0
16	gate	fence	camera	0.65	0.0
17	letters	emails	software updates	0.63	0.0
18	cake	pie	swords	0.62	0.0
19	sandals	boots	toothbrush	0.45	0.0
20	helicopter	airplane	bus	0.62	0.1
21	cucumbers	tomatoes	beers	0.58	0.0
22	shorts	jeans	book	0.58	0.1
23	sculptor	painter	lawyer	0.58	0.0
24	oven	stove	garage	0.57	0.1
25	milk	flour	sponges	0.56	-0.01
26	jacket	sweater	puzzle	0.56	0.07
27	batteries	charger	snacks	0.54	0.00
28	basement	attic	lease	0.55	0.08
29	knives	spoons	bed	0.55	0.11
30	sister	mother	dog	0.54	0.09
31	bag	purse	camera	0.54	0.06
32	blankets	pillows	food	0.54	0.03
33	nurses	doctors	carpenters	0.52	0.02
34	apples	pears	salmon	0.51	0.05
35	shampoo	soap	vitamins	0.50	0.02
36	thyme	parsley	candy	0.49	0.12
37	strawberries	cherries	toilet paper	0.48	0.04
38	faucet	sink	alarm system	0.48	0.04
39	kayaks	canoes	camper vans	0.47	0.04
40	eyeshadow	lipstick	keys	0.46	0.03
41	sheep	goats	fish	0.46	0.04
42	pasta	pizza	water	0.44	0.02
43	scarves	gloves	teapots	0.44	0.1
44	palms	pinetrees	tulips	0.43	0.04
45	screws	nails	lightbulb	0.43	-0.03
46	bracelet	necklace	computer	0.42	0.02
47	phone	alarm	wind	0.41	0.11
48	houses	apartments	bridge	0.40	0.06

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