Readers access discourse representations rapidly during alternative set activation

Morwenna Hoeks[a]*, Maziar Toosarvandani[a] & Amanda Rysling[a]
*Corresponding author

[a]*University of California Santa Cruz, 1156 High Street, Santa Cruz, 95064, California, United States*

Author Note

The data reported in this paper, as well as the analysis code and materials are made available via the Open Science Framework and can be accessed on `https://osf.io/svq6c/?view_only=75184df3a9174f56a640d7c166fe0f9e`. The results of these experiments were presented at the 2023 Conference on Human Sentence Processing. We have no conflicts of interests to disclose.

Correspondence concerning this article should be addressed to Morwenna Hoeks, Institute of Cognitive Science, University of Osnabrück, 49069 Osnabrück. Email: morwennahoeks@gmail.com

Abstract

Linguistic focus triggers the activation of contrastive alternatives, with priming studies suggesting that comprehenders first activate semantic associates, and then select alternatives from among them: the Activation-Selection model (Husband and Ferreira 2015). However, reading, memory, and visual world studies have shown that comprehenders also utilize world-knowledge and discourse information to identify alternatives (Sedivy, 2002; Fraundorf et al., 2013; Kim et al., 2015). A conservative extension of the Activation-Selection model, in which discourse information is used in addition to structural information to select appropriate alternatives, predicts that any effect of the contextual (in)appropriateness of alternatives should not be contemporaneous with the effect of semantic association—contextual information should be used only after semantic association has activated an initial candidate set. Three Maze reading studies tested these predictions. In Experiment 1, at a stage of processing where effects of semantic association were still active, slowdowns were observed on expressions that were contextually ruled out as possible alternatives to a preceding focus, despite being explicitly mentioned in the context. Moreover, in Experiment 1, slowdowns due to contextual exclusion were found on non-associated alternatives, suggesting that contextually appropriate alternatives are not solely selected by suppressing activation on semantic associates. These slowdowns must be attributed to comprehension processes initiated by a reader when encountering linguistic focus. In Experiment 2, they disappeared when an explicit cue to a focus (a focus particle) was absent. Contextual exclusion slowdowns were also observed at a later stage of processing in Experiment 3, after effects of semantic association had disappeared. We propose a less conservative extension of the Activation-Selection model, in which comprehenders rapidly access discourse in-

formation to rule out salient potential alternatives whose activation does not depend solely on the priming of semantic associates.

Keywords: Linguistic focus Contrastive alternatives Discourse Maze task Selection

---

Introduction

Sometimes to understand a scene or situation, understanding what is not there is just as important as understanding what is. Studies in language processing have demonstrated that comprehenders need to consider *constrastive alternatives*—expressions that contrast with, and substitute for, some expression in a sentence—in order to understand the message it conveys. For example, a comprehender can, at least in some contexts, come to understand the sentence *Jane has only an apple* to mean that Jane has nothing else to eat besides an apple, such as a sandwich or banana. But the specific inference that the comprehender of this sentence will draw depends on the context in which it is used. If Jane is alone in the kitchen at night and hears a burglar breaking into her house, they might instead conclude that Jane has nothing else to defend herself with, besides an apple (Kim et al., 2015). This article investigates how what has previously been said in a discourse determines the specific alternatives that come to mind when a sentence is comprehended.

The need to consider such alternatives is signaled by varied linguistic devices, including *focus*, which in English is marked both by intonation and by focus particles (e.g., *only*, *even*, *also,...*) or constructions (e.g., a cleft: *it was...that...*). In the example sentence above, the particle *only* and a falling pitch accent on *apple* together indicate that a set of alternatives to apples needs to be considered. A growing body of research has investigated how both focus intonation and focus particles lead to the activation of a focused expression's contrastive alternatives in online comprehension, using measures from reading, visual world, priming, and memory tasks to probe the interaction of conceptual, structural,

and contextual information in the alternative set activation process (Braun and Tagliapietra, 2010; Fraundorf, Watson, and Benjamin, 2010; Fraundorf, Benjamin, and Watson, 2013; Spalek, Gotzner, and Wartenburger, 2014; Kim, Gunlogson, Tanenhaus, and Runner, 2015; Gotzner, Wartenburger, and Spalek, 2016; Braun, Asano, and Dehé, 2018; Yan and Calhoun, 2019; Hoeks, Toosarvandani, and Rysling, 2023).

The evidence across these different tasks has failed to converge on a unified understanding of the time course of alternative set consideration in sentence processing. Evidence from priming tasks suggests that while conceptual information shapes the alternative set early on by activating semantic associates of the focused expression, structural information is only integrated at a later stage of processing (Husband and Ferreira, 2015). 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), and visual world studies have suggested that this contextual information may play a role early on in the processing of contrastive alternatives (Kim et al., 2015). However, since these studies either used offline tasks or did not explicitly test the interaction between contextual 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.

We present three reading studies, which aim to shed light on the time-course of alternative set processing while the comprehension of discourse is still ongoing. Their results indicate that the role linguistic contextual information plays in alternative set processing is distinct from the role of conceptual information. In Experiments 1 and 3, 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 1, these slowdowns were observed at the same time as effects of

semantic association were found, for alternatives that directly followed a focus and for alternatives that were not semantically associated to the preceding focus. This suggests (i) that contextual information affected reading times at an early stage of processing, i.e., at a stage where semantic association effects were still active; and (ii) that effects of contextual information do not depend on alternatives being semantically associated to the focus. Since slowdowns on contextually excluded alternatives were not observed when a focus particle was absent in Experiment 2, such slowdowns can therefore only be explained via a processing mechanism which utilizes contextual information particularly in the activation of focus alternatives. Experiment 3—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. By crossing conceptual properties of the potential alternatives with their contextual fit, these studies show that contextually appropriate alternatives are not solely selected for by suppressing activation on semantic associates, and that linguistic contextual information is used rapidly in the activation of alternatives.

All three experiments used the Maze task (Forster et al., 2009) to test the on-line construction of alternative sets. Lowder et al. (2021) showed that readers utilize focus particles as a cue to begin anticipating upcoming sentence continuations, but in the absence of a discourse context; other studies, which manipulated discourse context, did not use reading measures (Fraundorf et al., 2010; Washburn et al., 2011; Fraundorf et al., 2013; Kim et al., 2015). Building on these two lines of work, the studies presented here measured reading times on a potential alternative expression as readers proceeded incrementally through the sentence, thus probing the extent to which processing of a focus may facilitate reading of subsequent alternatives, while the comprehension of a sentence is still ongoing. We motivate the design of these experiments next.

Evidence for early effects of conceptual information and late effects of 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 and 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 the sentences in which the prime word had occurred.

In later work, Husband and Ferreira (2015) probed the time-course of this alternative activation by manipulating the delay between presentation of the prime, in a sentence like (1), and a target.

(1) **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 and Ferreira (2015) took these findings as evidence for a two-stage model of alternative set construction in which first semantic associates 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. (2016) 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.

This model of alternative set processing 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*, response times in 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 and Swinney, 1981; Seidenberg et al., 1982; Tanenhaus et al., 1979). Similarly to the facilitation 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* as-

sociated 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, reviewed next, establishes a role for the discourse context in the construction of alternative sets, suggesting that the mechanisms through which comprehenders activate alternatives must also be sensitive to contextual information.

In what follows, we identify three particular ways in which the plausibility of an alternative can be determined by context. An expression can become a plausible alternative in a particular context by being:

(i) **Mentioned:** an expression is salient because it was explicitly mentioned in the preceding discourse;

(ii) **Situationally available:** 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) **Incidentally excluded:** even though it is mentioned, information in the preceding context may rule out an otherwise predictable expression as a plausible alternative.

Below, we discuss behavioral evidence which suggests that the processing of alternative sets is affected by context in all three ways.

Effects of explicit mention of alternatives

Washburn et al. (2011) showed that explicitly mentioned alternatives become activated in the processing of focus. In a cross-modal priming task, they kept target (*locks*) constant across conditions, as shown in (2), 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*).

(2) **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, indicating 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 converges 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 (3a–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 (3c–e).

(3) 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 activation of focus alternatives—and that contextually salient, but non-associated alternatives become activated as early as the semantic associates in Husband and Ferreira's (2015) study. The targets in Washburn et al.'s were presented 250ms after the offset of the primes, indicating that merely mentioned alternatives may also be part of the initially activated cohort of 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. These findings do not fit clearly into the time-course of alternative set construction proposed by Husband and Ferreira (2015), as they suggest that contextual information may impact alternative set processing before conceptual information about the focus is available.

Mentioned alternatives help anticipate foci

In a visual world study by Kim et al. (2015), listeners heard a target sentence containing a focus in a context, as in (4). Fixations began to converge earlier on the focused target (*apples*) when it was mentioned in the preceding context.

(4) **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) support the conclusion that contextual contrasts help anticipate a focus. These showed that the presence or absence of contrastive alternatives in a context sentence, as in (5a–b), affected parsing decisions in sentences that were temporally ambiguous between a main clause and a reduced relative, as in (5c–d).

(5) **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 reduced reading times on the critical region (*passed*), indicating that the garden path effect typically found on this region was modulated by contextual mention of contrastive alternatives. Readers thus 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) pointed 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 be considered 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, we 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 and 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.

Effects of situation-specific information

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 (6a-b), than in contexts compatible with a wider range of alternatives, like (6c-d)—even when the target itself wasn't explicitly mentioned.

(6) **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.

Besides explicitly mentioned alternatives themselves, overt contextual material can also

set up a particular situation, which can guide listeners' expectations about upcoming focus alternatives as well. The context in (6b) 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 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 are 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. Below, we discuss evidence of effects of incidental, discourse-specific information on the activation of alternatives that cannot be attributed to semantic priming or general predictability based on world knowledge.

Incidentally ruled out alternatives

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 information which rules out expressions as plausible alternatives to a focus, building on independent findings that this information can restrict the interpretation of referring expressions that are in principle ambiguous (Brown-Schmidt and 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 (7), where Saturn, Neptune and Jupiter are all mentioned exactly once in the described incident but in the target sentence only Saturn is a plausible alternative to Jupiter.

(7) 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.

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*). The incidental 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 or excluding 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 in their studies. 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, 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, we put forward a hypothesis about how this process plays out, and how it can be tested.

Testing the role of context in alternative set processing

Husband and Ferreira (2015) proposed a model 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 context subsequently leads to the inhibition of expressions that are either structurally illicit or implausible alternatives to the focus. This is a conservative extension because it maintains the basic architecture of alternative set construction in which the relevant alternatives are selected from among a large cohort of expressions that become activated via a domain-general mechanism.

This conservative extension of the Activation-Selection model makes two predictions, which Experiment 1 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, after effects of semantic association have already decayed. Experiment 1, as well as the subsequent experiments, thus made use of on-line reading measures to test when discourse-specific information that incidentally 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 contextual information only affects those alternatives that first become activated due to their being semantically associated to the focus. Experiment 1 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.

Experiment 1

Experiment 1 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 on-line 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 is non-associated (as in *...only **forks**, but no **pears***). All else being equal, this difference in activation between associated and non-associated alternatives should be realized as a difference in reading times on the alternative that directly follows the focus, such that associated alternatives are read faster. 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 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 a conservative extension of the Activation-Selection model.

Data Availability

All materials, data and analysis code of this and subsequent experiments are made available via the Open Science Framework and can be accessed at `https://osf.io/svq6c/?view_only=75184df3a9174f56a640d7c166fe0f9e`. This study's design and its analysis were not pre-registered.

Method

Materials. In Experiment 1, 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. An example item in all four conditions is shown in (8).

(8) **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*$_{\text{(a-b)}}$ | an *ash-tray*$_{\text{(c-d)}}$ } but no **cheese** to the table where the tourist was seated.

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 (excluded) or not (non-excluded). In the non-excluded conditions, the target alternative inside the target sentence 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, based on the described incident, ruled it out as a potential alternative to the focus.

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 (8), 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 incident described by the target sentence contrasted items that the waiter remembered to bring with items that the waiter did not remember to bring.

For this reason, the target sentence in the excluded conditions, i.e., in (8b) and (8d), may be considered unnatural because it is not coherent with the preceding context. Af-

ter all, it contrasts an alternative with the focus that is not relevant as an alternative to that focus. Obtaining longer reading times on these target alternatives would therefore be unsurprising, assuming that comprehenders already integrate the relevant contextual information in reading the target sentence. However, this is not a confound but an intentional feature of the design: Results from Experiment 1 and subsequent experiments show that comprehenders only slow down on excluded target alternatives in certain cases. In Experiment 2, for instance, these slowdowns crucially disappear when the focus particle *only* is removed from the target sentence, suggesting that comprehenders are less sensitive to incidental information from the discourse context in the absence of a clear cue to the presence of focus marking.

In addition to contextual exclusion, semantic association between the focus and target alternative was manipulated by varying the nature of the focus that preceded the target alternative. 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. Thus, for each condition in the example item set above, the context was different (8a–d), while the target sentence varied between associated (8a–b) and non-associated (8c–d) conditions.

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 II for a list of all such alternative triplets.

In total, 48 items were constructed, each with the four conditions as illustrated in (8). All items for Experiment 1 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. As in the more commonly used self-paced reading task, this tasks measures response times using button presses. This task was chosen in particular because it encourages highly incremental processing due to the fact that participants advance through a sentence not by simply pressing a button, but by choosing at each word which of two items is the correct continuation of that sentence. Participants in the Maze task thus see each word in the target sentence presented alongside a distractor word (or *foil*) which would not make a sensical continuation. An example of one target item is given in (9) below, with the foil presented below the corresponding intended word of the target sentence.

(9) 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 is also argued to provide 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. 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 *suprisal* 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).

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. 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 that encouraged careful reading of the preceding context. For instance, the example item in (8) was followed by the comprehension question in (10).

(10) 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.

Results

The mean comprehension question accuracy for Experiment 1 was 85%, and the mean completion rate of the maze target sentences was 87%. Due to participants' failure to complete target sentences, 172 observations on the critical region were missing (7% of all trials). Response times above 7000ms were excluded from the analysis (amounting to one observation on the critical region).

Mean response times for the target word (*cheese*) and its surrounding regions in all conditions are given in Table 1. They are plotted with 95% confidence intervals in Figure 1.

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.

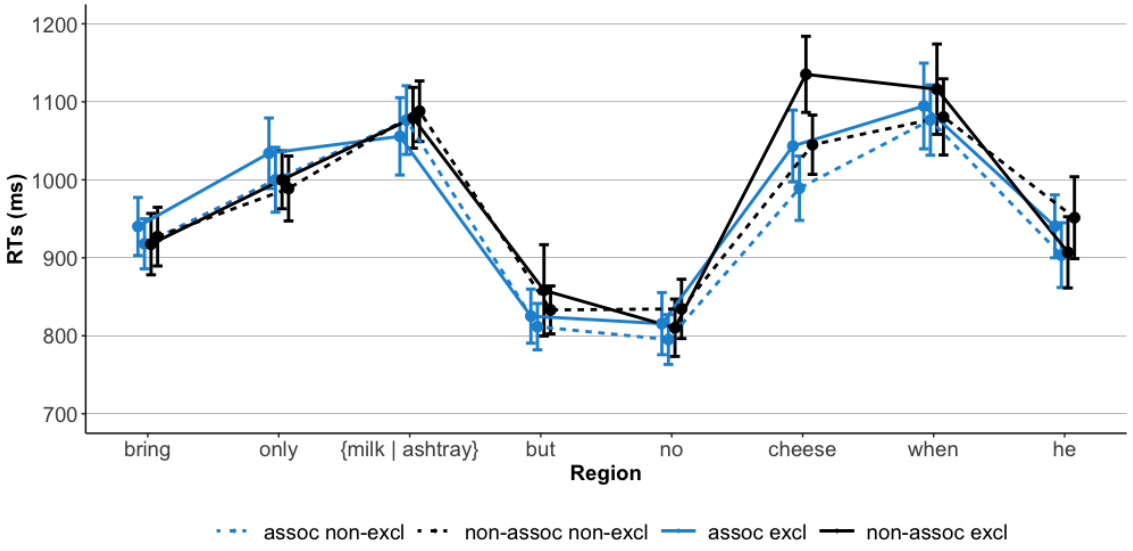

Figure 1: mean RT in each region per condition of Experiment 1. Error bars represent 95% confidence intervals.

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 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.

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 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).

Tables 2 and 3 present the posterior estimates obtained in the models of Experiment 1 log-transformed response times and untransformed response times on target words, respectively. Posterior model estimates are 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.

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, and so this main effect will not be considered reliable here. However, pairwise comparisons revealed that non-associated excluded target alternatives were responded to more slowly than non-associated non-excluded targets, for

	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 2: Posterior model estimates for the population-level effects of Bayesian mixed effects model on logRTs of Experiment 1.

	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 3: Posterior model estimates for the population-level effects of Bayesian mixed effects model on untransformed RTs of Experiment 1.

both log-transformed (β =0.025; 97.5% Cr.I=[0.0006,0.05]) and untransformed response times (β =86.92; 97.5% Cr.I=[9.29, 165.15]).

Discussion

In Experiment 1, 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 encoun-

tered. As such, 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 1, alternatives were explicitly mentioned in the preceding context in all conditions, so the differences in response times among excluded and non-excluded alternatives cannot be attributed to their relative salience alone, unlike the results from previous studies showing an early effect of explicit mention.

On its own, the slowdown on contextually excluded alternatives may not be surprising because mention of these alternatives may have led to incoherence with the preceding context. The incident described in the context sentences of the excluded conditions already made the target alternatives less natural contrasts with the focus, and the slowdown on such alternatives may thus have been caused by this reduction in naturalness. The fact that such slowdowns indeed arose tells us, first, that comprehenders form expectations about upcoming expressions based on information that is specific to the particular incident described in the discourse context. For the example items in (8), this information tells us what objects are in which location.

Importantly, comprehenders were only sensitive to discourse information that led to incoherence when alternatives were not closely associated to the focus. Distinguishing between these contextually appropriate non-associated alternatives and inappropriate ones could not be accomplished by relying on lexical or conceptual knowledge, because the difference in their appropriateness was solely determined by information from the discourse context. This indicates that the mechanism through which incidental discourse information is utilized by comprehenders in order to determine incoherence does not solely rely on activation of semantic associates. The effect of contextual exclusion observed in Experiment 1 therefore 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 by a the incorporation of more incidental discourse information independently from any general conceptual or world knowledge.

Still, 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, not to the calculation of alternatives in the processing of focus in particular. In Experiment 2, we therefore test reading times on target alternatives in the absence of a clear cue to the presence of focus marking. Results of this experiment showed that contextual exclusion effects disappeared in case the target sentence did not contain a focus particle, suggesting that comprehenders' reasoning about incidental discourse information is in fact only triggered at this stage in the presence of such a particle.

In light of these results, the contextual exclusion slowdowns observed in Experiment 1 can only be explained in terms of a focus-specific mechanism which is sensitive to incidental information early on. The present results would therefore 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. This 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 discourse itself, and not *just* by virtue of these alternatives being salient or activated via comprehenders' general conceptual or world knowledge.

Experiment 2

To establish that reading time differences on the target alternatives in Experiment 1 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 2. Experiment 2 tests whether the contextual exclusion effect observed in Experiment 1 is still observed when the focus particle is removed. If the 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.

Method

Materials. The materials of Experiment 2 were identical to the materials of Experiment 1, except that the focus particle *only* was removed from all target sentences, as in the example item set in (11).

(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 { *milk* | an *ashtray* } 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 4: Experiment 2: 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 1.

Results

The mean comprehension question accuracy was 79%, and the mean completion rate of the maze target sentences of Experiment 2 was 89%. Due to participants' failure to complete target sentences, 200 observations on the critical region were missing (8% of all trials). Response times above 7000ms were excluded from the analysis (amounting to one observation on the critical region).

Mean response times for the target word and its surrounding regions in all conditions are given in Table 4. They are plotted with 95% confidence intervals in Figure 2.

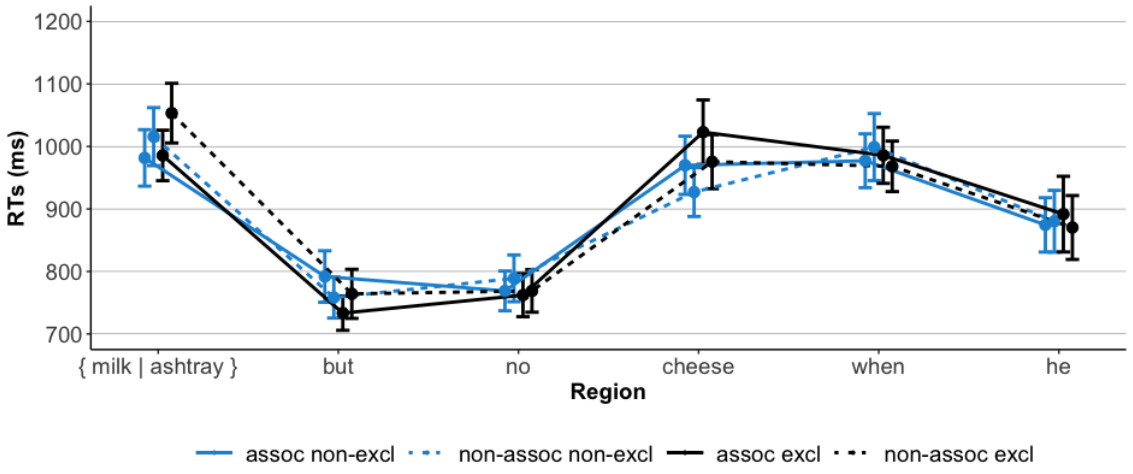

Figure 2: Experiment 2: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

The data analysis was analogous to that of Experiment 1, with models including fixed effects of semantic association and contextual exclusion (deviation-coded), and with associated and non-excluded conditions treated as reference levels. Tables 5 and 6 present the posterior model estimates results for the log-transformed response times and untransformed response times on target words of Experiment 2, respectively. 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 (β =0.004; 97.5% Cr.I=[-0.027, 0.020]) and untransformed (β =6.92; 97.5% Cr.I=[-71.5, 58.15]) response times.

	Estimate	Est.Error	95% CrI	Rhat	Bulk_{ESS}	Tail_{ESS}
(Intercept)	2.96	0.02	[2.93,2.99]	1.00	1885	3622
Association	0.02	0.01	[0.00,0.03]	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: Model estimates for the population-level effects of Bayesian mixed effects model on logRTs of Experiment 2.

	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 6: Model estimates for the population-level effects of Bayesian mixed effects model on raw RTs of Experiment 2.

Discussion

The effect of contextual exclusion found in Experiment 1 was not observed in Experiment 2. Experiment 1 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 2, in which a focus particle was absent from target sentences. This indicates that the effect of contextual exclusion observed on alternatives in Experiment 1 was indeed due to the processing of the 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 1, 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).

To account for the way in which such contextual information is utilized in the processing of focus, above we first considered a conservative extension of the Activation-Selection model. This model predicted, first, that the effect of contextual exclusion appears at a later stage of processing, after the effect of semantic association has already faded over time; and, second, that contextual exclusion effects could only arise on alternatives that were semantically associated in the first place. The results of Experiment 1 falsify both these predictions: Effects of contextual exclusion were observed at a stage of processing where effects of semantic association were still present and slowdowns due to contextual exclusion were observed on non-associated alternatives, suggesting that contextually appropriate alternatives are not selected from among previously activated semantic associates. Because Experiment 2 showed that these contextual exclusion effects were focus-specific, 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 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 1 and Experiment 2. As Husband and Ferreira

(2015) suggest, it seems reasonable to assume that semantic association plays a very general role, giving rise to facilitative effects 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 later difference in RTs between 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 treated 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 3 was designed to test how semantic association and contextual exclusion interact at a later stage of processing than Experiments 1 and 2 investigated.

Experiment 3

Like Experiment 1, Experiment 3 crossed association between the focus and the target alternative with contextual exclusion of those target alternatives. But unlike Experiment 1, it measured response times on alternatives with a longer 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 3 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 into this later target position.

Method

Experiment 3 makes use of the same context sentences as those used in Experiment 1 and Experiment 2, but the target sentences in Experiment 3 were constructed such that the distance between the focus and the target alternative inside the target sentences was longer than those in Experiment 1.

Materials. Materials of Experiment 3 were identical to the materials of Experiment 1, 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 3 is given in (12).

(12) **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 | an ashtray } 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 1 and Experiment 2.

Results

The mean comprehension question accuracy for Experiment 3 was 85%, and the mean completion rate of the maze target sentences of Experiment 3 was 89%. Due to partic-

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

ipants' failure to complete target sentences, 265 observations on the critical region were missing (11% of all trials). Response times above 7000ms were excluded from the analysis (amounting to one observation on the critical region).

Mean response times for the target word and its surrounding regions in all conditions are given in Table 7. They are plotted with 95% confidence intervals in Figure 3.

The data analysis was analogous to that of Experiment 1 and Experiment 2, with models including fixed effects of semantic association and contextual exclusion (deviation-coded), and with associated and non-excluded conditions treated as reference levels. Tables 8 and 9 present the posterior estimates for the models of Experiment 3 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 more slowly than target 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 (β =-0.027; 99% Cr.I=[-0.044,-0.010]) and untransformed (β =73.95; 99% Cr.I=[9.61,135.04]) response times. Moreover, as in Experiment 1, the difference between the non-associated excluded condition and the non-associated non-excluded conditions

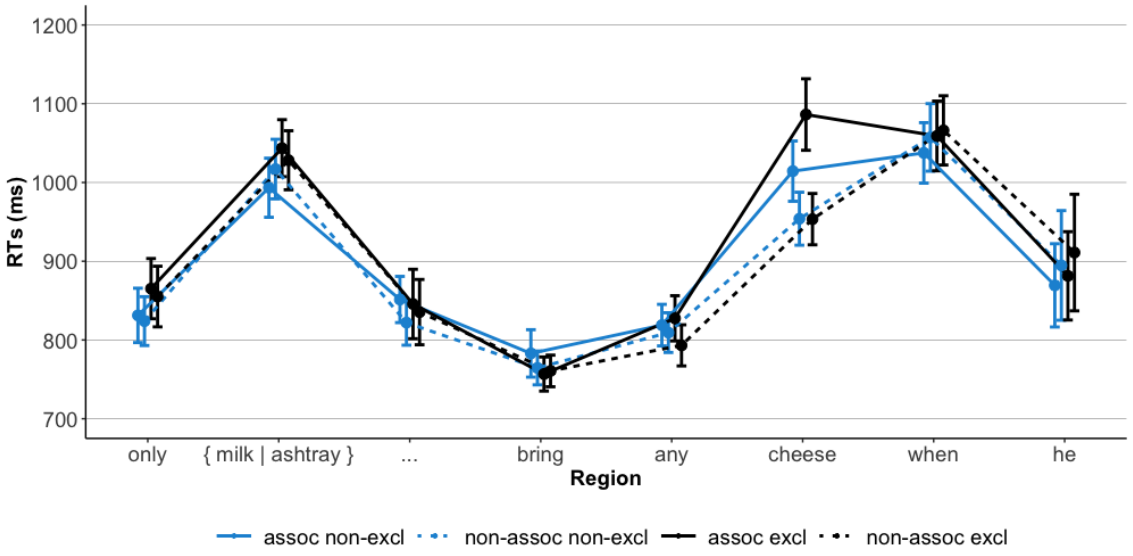

Figure 3: Experiment 3: mean RT in each region in each condition. Error bars represent the 95% confidence interval.

	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 8: Posterior estimates for the population-level effects of Bayesian mixed effects model on logRTs of Experiment 3.

	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 9: Posterior estimates for the population-level effects of Bayesian mixed effects model on raw RTs of Experiment 3.

was again reliable in both log-transformed (β =0.045; 99% Cr.I=[0.025,0.064]) and untransformed (β =128.55; 99% Cr.I=[51.16, 204.17]) response times.

Discussion

In Experiment 3, RTs on contextually excluded alternatives were longer than those on alternatives that were not contextually excluded. In addition, the effect of semantic association 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.

Experiment 3 thus replicated the effect of contextual exclusion. The main difference

with the pattern of results obtained in Experiment 1 is that in Experiment 3 the effect of contextual exclusion was also reliable among the conditions with semantically associated target alternatives. This effect is consistent both with the conservative extension of the Activation-Selection model, in which contextually appropriate alternatives are selected from among semantic associates, and with a less conservative 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 later stage of processing. However, the overall response time pattern in Experiment 3 is consistent only with a model in which contextual information and semantic association are dealt with separately, for two reasons.

First, as in Experiment 1, the slowdown on contextually excluded non-associated alternatives, in particular relative to non-associated non-excluded ones, can only be explained if incidental 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 3, not even a numerical one, despite Experiment 1 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. 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.

General discussion

Three reading studies tested the nature and time-course of the information comprehenders utilize to activate contrastive alternatives in the processing of focus. Target sentences tested how the processing of a focus introduced by a particle (*only)* affected how an alternative, explicitly mentioned after the focus, was read. Preceding contexts always mentioned such alternative expressions, manipulating whether they were either contextually appropriate as alternatives to the focus or not.

The results of Experiment 1 and Experiment 3 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. Experiment 1, in particular, showed that this type of contextual information can be taken into account for material in close proximity to the focus itself. The results of Experiment 2 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.

These experiments were designed to test a conservative extension of the Activation-Selection model (Husband and Ferreira, 2015), in which comprehenders use discourse information as well as structural information to select contextually appropriate alternatives from an initially activated set of semantic associates. As in Husband and Ferreira's original proposal, contrastive alternatives to a focus become activated in two sequential steps.

First, when the meaning of the focused lexical material is retrieved, activation is spread to expressions that are conceptually associated with the expression in focus. Structurally appropriate and contextually relevant alternatives are selected for by suppressing activation of non-contrastive and/or non-contextually relevant associates on the basis of structural (semantic type or selectional restrictions of the focus' environment), situation-specific and incidental discourse information (contextual plausibility). This predicts, first, that effects of contextual exclusion can only be found after effects of semantic association have already decayed; and second, that contextual information only affects those expressions that first become activated via their semantic association with the expression in focus.

The results of Experiments 1-3 were only partially in line with this conservative extension of Husband and Ferreira's original Activation-Selection model. These results suggested that early activation of associates may temporarily override finer-grained context-specific preferences, because semantically associated but contextually excluded alternatives were facilitated alongside contextually appropriate alternatives in Experiment 1. But they also indicate that such context-specific preferences can help facilitate non-associated but contextually appropriate alternatives—both in early (Experiment 1) and later stages of focus processing (Experiment 2). 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.

It may be that contextual information affects the activation of focus alternatives because comprehenders re-activate their representations of the discourse context directly, and generate alternatives based on such representations. This less conservative extension of the Activation-Selection model suggests that contrastive alternatives to a focus can become activated by one of two non-sequential mechanisms: they become activated by spreading activation to semantically associated expressions and later suppressing activation on in-

appropriate associate, or they are directly generated by revisiting representations of the discourse context that specify which alternatives contrast with the focus.

This less conservative extension still remains underspecfied in some respects, however. One way of fleshing it out in more mechanistic terms would adopt a model of discourse comprehension like Van Dijk and Kintsch (1983), in which discourse understanding 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 1) and late facilitation of contextually appropriate alternatives (Experiment 3), 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 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.

References

E. Husband, F. Ferreira, The role of selection in generating focus alternatives, Language, Cognition and Neuroscience 31 (2015) 217–235.

J. C. Sedivy, Invoking discourse-based contrast sets and resolving syntactic ambiguities, Journal of Memory and Language 46 (2002) 341–370.

S. H. Fraundorf, A. S. Benjamin, D. G. Watson, What happened (and what did not):

Discourse constraints on encoding of plausible alternatives, Journal of Memory and Language 69 (2013) 196–227.

C. S. Kim, C. Gunlogson, M. K. Tanenhaus, J. T. Runner, Context-driven expectations about focus alternatives, Cognition 139 (2015) 28–49.

B. Braun, L. Tagliapietra, The role of contrastive intonation contours in the retrieval of contextual alternatives, Language and Cognitive Processes 25 (2010) 1024–1043.

S. H. Fraundorf, D. G. Watson, A. S. Benjamin, Recognition memory reveals just how contrastive contrastive accenting really is, Journal of memory and language 63 (2010) 367–386.

K. Spalek, N. Gotzner, I. Wartenburger, Not only the apples: Focus sensitive particles improve memory for information-structural alternatives, Journal of Memory and Language 70 (2014) 68–84.

N. Gotzner, I. Wartenburger, K. Spalek, The impact of focus particles on the recognition and rejection of contrastive alternatives, Language and Cognition 8 (2016) 59–95.

B. Braun, Y. Asano, N. Dehé, When (not) to look for contrastive alternatives: the role of pitch accent type and additive particles, Language and Speech 62 (2018) 751–778.

M. Yan, S. Calhoun, Priming effects of focus in mandarin chinese, Frontiers in Psychology 10 (2019) 1985.

M. Hoeks, M. Toosarvandani, A. Rysling, Processing of linguistic focus depends on contrastive alternatives, Journal of Memory and Language 132 (2023) 104444.

K. I. Forster, C. Guerrera, L. Elliot, The maze task: Measuring forced incremental sentence processing time, Behavior research methods 41 (2009) 163–171.

M. W. Lowder, G. Ryan, J. Opie, E. Kaminsky, Effects of contrastive focus on lexical predictability during sentence reading: The case of not only... but also constructions, Quarterly Journal of Experimental Psychology 74 (2021) 179–186.

M. B. Washburn, E. Kaiser, M. L. Zubizarreta, Focus facilitation and non-associative sets, 2011.

C. Conrad, Context effects in sentence comprehension: A study of the subjective lexicon, Memory & Cognition 2 (1974) 130–138.

M. M. Lucas, Frequency effects on the processing of ambiguous words in sentence contexts, Language and Speech 30 (1987) 25–46.

W. Onifer, D. A. Swinney, Accessing lexical ambiguities during sentence comprehension: Effects of frequency of meaning and contextual bias, Memory & Cognition 9 (1981) 225–236.

M. S. Seidenberg, M. K. Tanenhaus, J. M. Leiman, M. Bienkowski, Automatic access of the meanings of ambiguous words in context: Some limitations of knowledge-based processing, Cognitive psychology 14 (1982) 489–537.

M. K. Tanenhaus, J. M. Leiman, M. S. Seidenberg, Evidence for multiple stages in the processing of ambiguous words in syntactic contexts, Journal of verbal learning and verbal behavior 18 (1979) 427–440.

R. A. Zwaan, G. A. Radvansky, Situation models in language comprehension and memory., Psychological bulletin 123 (1998) 162.

S. Brown-Schmidt, M. K. Tanenhaus, Real-time investigation of referential domains in unscripted conversation: A targeted language game approach, Cognitive science 32 (2008) 643–684.

T. K. Landauer, P. W. Foltz, D. Laham, An introduction to latent semantic analysis, Discourse processes 25 (1998) 259–284.

E. M. Husband, Prediction in the maze: Evidence for probabilistic pre-activation from the english a/an contrast, Glossa Psycholinguistics 1 (2022).

V. Boyce, R. Futrell, R. P. Levy, Maze made easy: Better and easier measurement of incremental processing difficulty, Journal of Memory and Language 111 (2020) 104082.

J.-B. Michel, Y. K. Shen, A. P. Aiden, A. Veres, M. K. Gray, J. P. Pickett, D. Hoiberg, D. Clancy, P. Norvig, J. Orwant, et al., Quantitative analysis of culture using millions of digitized books, Science 331 (2011) 176–182.

R Core Team, R: A language and environment for statistical computing, 2021.

P.-C. Bürkner, brms: An r package for bayesian multilevel models using stan, Journal of statistical software 80 (2017) 1–28.

R. H. Baayen, D. J. Davidson, D. M. Bates, Mixed-effects modeling with crossed random effects for subjects and items, Journal of memory and language 59 (2008) 390–412.

T. A. Van Dijk, W. Kintsch, Strategies of discourse comprehension, Academic press New York, 1983.

Appendix A

		Materials in the assoc non-excl condition
1	**Context:**	The tourist had asked for a variety of items, such as cheese and some yogurt. There was already an ashtray on the table.
	Target:	When the waiter returned, he remembered to bring only some yogurt but no cheese to the table.
2	**Context:**	At the bar yesterday, John had ordered some wine and some beer. He didn't order any nuts the whole evening.
	Target:	All of a sudden, he had to leave quickly and he finished only his beer but not his wine when he stood up.
3	**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.
	Target:	I got a call back only from my aunt but not from my uncle, before the end of the weekend.
4	**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.
	Target:	She showed Erin only a piano but not a violin, while Erin was at her house.
5	**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.
	Target:	This summer, Ben's uncle will keep raising only some horses but no ponies, even though Ben liked them very much.
6	**Context:**	The corner store sells a bunch of things, such as magazines and newspapers. They never sold any cigarettes.
	Target:	Last summer, they only stopped selling newspapers but not magazines due to supply chain issues.
7	**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.
	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.
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.

Appendix B

Alternatives and LSA scores

	alt1 (target)	alt2 (assoc)	alt3 (non-assoc)	alt1-alt2	alt1-alt3		alt1 (target)	alt2 (assoc)	alt3 (non-assoc)	alt1-alt2	alt1-alt3
1	yogurt	cheese	ashtray	0.86	-0.0	25	milk	flour	sponges	0.56	-0.01
2	beer	wine	nuts	0.85	0.07	26	jacket	sweater	puzzle	0.56	0.07
3	aunt	uncle	bank	0.82	0.01	27	batteries	charger	snacks	0.54	0.00
4	piano	violin	clocks	0.80	0.10	28	basement	attic	lease	0.55	0.08
5	horses	ponies	ducks	0.79	0.06	29	knives	spoons	bed	0.55	0.11
6	newspapers	magazines	cigarettes	0.75	0.06	30	sister	mother	dog	0.54	0.09
7	metro station	bus station	swimming pool	0.75	0.11	31	bag	purse	camera	0.54	0.06
8	screwdriver	hammer	soap	0.59	0.08	32	blankets	pillows	food	0.54	0.03
9	chair	sofa	flowerpot	0.73	0.05	33	nurses	doctors	carpenters	0.52	0.02
10	radio	tv	bike	0.70	0.01	34	apples	pears	salmon	0.51	0.05
11	chemistry	biology	sports	0.68	0.04	35	shampoo	soap	vitamins	0.50	0.02
1000 12	lions	tigers	pelicans	0.68	0.08	36	thyme	parsley	candy	0.49	0.12
13	socks	shoes	pencils	0.67	0.09	37	strawberries	cherries	toilet paper	0.48	0.04
14	cotton	wool	metal	0.67	0.0	38	faucet	sink	alarm system	0.48	0.04
15	doors	windows	tape	0.66	0.0	39	kayaks	canoes	camper vans	0.47	0.04
16	gate	fence	camera	0.65	0.0	40	eyeshadow	lipstick	keys	0.46	0.03
17	letters	emails	software updates	0.63	0.0	41	sheep	goats	fish	0.46	0.04
18	cake	pie	swords	0.62	0.0	42	pasta	pizza	water	0.44	0.02
19	sandals	boots	toothbrush	0.45	0.0	43	scarves	gloves	teapots	0.44	0.1
20	helicopter	airplane	bus	0.62	0.1	44	palms	pines	tulips	0.43	0.04
21	cucumbers	tomatoes	beers	0.58	0.0	45	screws	nails	lightbulb	0.43	-0.03
22	shorts	jeans	book	0.58	0.1	46	bracelet	necklace	computer	0.42	0.02
23	sculptor	painter	lawyer	0.58	0.0	47	phone	alarm	wind	0.41	0.11
24	oven	stove	garage	0.57	0.1	48	houses	apartments	bridge	0.40	0.06