A model for pragmatic strengthening – Evidence from a new priming paradigm

Nadine Bade[*] WooJin Chung[†] Léo Picat[‡] Rachel Dudley[§]

Salvador Mascarenhas[¶]

October 2021

Abstract   The paper further explores the role of different types of alternatives in pragmatic reasoning. Using experimental evidence from a novel priming paradigm, we look at the question whether the exclusion of contextual (focus) alternatives can prime different readings associated with simple and complex disjunction, as well as the converse. We find that while training people with exclusive readings of simple disjunction primes them to derive strong readings of other simple and complex disjunctions, it does not prime them to derive quantity-based implicatures with focus. However, the converse holds: priming them for strong readings of focus increases the rate of strengthened meanings for simple and complex disjunctions, as well as focused sentences. The main goal of the study is to inform models and theories of how pragmatic strengthening proceeds. Recently, Rees and Bott (2018) argued for a one-step model, where activation of the alternative is sufficient to activate the mechanism of strengthening. We suggest a revision of the model distinguishing between different types of alternatives based on our data. Rather than arguing for one specific theory, we will identify essential properties of a theory that is in line with this model.

Keywords   semantic priming, pragmatics, implicature

1   Introduction

There is an ongoing debate in the theoretical and experimental literature on whether all cases of quantity-based pragmatic strengthening can be subsumed under the same mechanism, and what its exact nature is (see e.g. Breheny et al., 2006; Magri, 2009;

---

[*]Department of Linguistics, University of Potsdam
[†]Department of Linguistics, Seoul National University
[‡]Université de Paris, UFR de médecine, F-75005 Paris, France
[§]Cognitive Development Center, Central European University
[¶]Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University

1

Huang and Snedeker, 2009; Geurts, 2010; Grodner et al., 2010; Franke, 2011; Chierchia et al., 2012; Chierchia, 2013; Spector, 2016). Two central questions in this debate are what role alternatives play in pragmatic strengthening, and whether a unified mechanism for deriving contextual versus scalar alternatives can be assumed (see e.g Horn, 1972; Levinson, 2000; Fox and Katzir, 2011; Breheny et al., 2013; Bott and Chemla, 2016; Rees and Bott, 2018; Waldon and Degen, 2020).

There is general agreement that quantity-based reasoning involves reasoning over alternatives based on the maxim of quantity ('Be informative') (Grice, 1989). The strengthened meaning of a sentence is its literal meaning plus the negation of its stronger, more informative alternatives. Moreover, it is widely accepted that there are two sources of alternatives: the lexicon and context. Lexical alternatives have been argued to play a dominant role in the derivation of scalar implicatures (generalized conversational implicatures). For example, the scalar implicature of (1a) is (1b). The literal meaning in (1a) contains a scalar expression – the disjunction 'or'. The implicature is derived by negating the non-weaker (not entailed) alternative containing a conjunction ('and'), its lexical competitor (Horn, 1972).

(1)   context: Yolanda had spinach and eggs for lunch.

 a. She liked the spinach or the eggs.   SIMPLE DISJUNCTION
 b. She did not like the spinach and the eggs.

Contextual alternatives play a role in the conversational implicatures of focus (Rooth, 1992). Sentence (2a) with focus on *spinach* evokes the question of what Yolanda liked. Given the context in (2), 'She liked the eggs' is a possible alternative (answer) which is not entailed by (2a), i.e. non-weaker. The strengthened meaning of (2a) is thus its literal meaning in (2a) plus the negation of that alternative (its particularized conversational implicature) given in (2b).

(2)   context: Yolanda had spinach and eggs for lunch.

 a. She liked [the spinach]$_F$.   FOCUS
 b. She did not like the eggs.

A central question addressed in the literature on quantity implicatures is what factors determine when and where the mechanism for their derivation is active. More recent theories in semantics and pragmatics assume that the mechanism can be operative locally, and that it can be obligatory (Magri, 2009; Chierchia, 2013). These questions have been investigated extensively using psycho-linguistic methods (Bott and Noveck, 2004; Breheny et al., 2006; Huang and Snedeker, 2009, 2011; Bott et al., 2012; Degen and Tanenhaus, 2015; Politzer-Ahles and Gwilliams, 2015). A number of different factors have been identified for triggering or blocking strengthening. A variety of models of how strengthening proceeds have been proposed as a result. Recently, the role alternatives play in activation and in these models has gotten greater scrutiny (Breheny et al., 2013; Degen and Tanenhaus, 2015; Rees and Bott, 2018; Waldon and Degen, 2020). Specifically, recent results offer diverging evidence for whether the presence and salience of alternative expressions is sufficient to automatically trigger strengthening. A related and persistent issue is what the alternatives are, and whether a model has

to distinguish between different types.

Our study further investigates the role of different alternatives in the automatic activation of strengthening by looking at pragmatic priming of the mechanism behind it across different scale types. Using a novel experimental paradigm exploiting feedback-based priming, we test whether the same pragmatic strengthening mechanism is involved in scalar cases with lexical alternatives exemplified by (1) and focus cases with contextual alternatives exemplified by (2). Additionally, we look further into the nature of alternatives by including more complex cases involving conjunction within a complex disjunction as in (3a). The sentence has two readings (beyond its literal meaning). The weaker one in (3b), which is the negation of the stronger alternative where 'or' is substituted by 'and', and the stronger reading one in (3c).

(3) context: Yolanda had spinach, eggs and potatoes for lunch.

    a.   She liked the spinach and the eggs, or she liked the potatoes.   COMPLEX DISJUNCTION

    b.   She did not like all three (the spinach and the eggs and the potatoes).

    c.   She liked the spinach and the eggs, but not the potatoes, or else she liked the potatoes but not the spinach and not the eggs.

The derivation of the reading in (3c) is more complex and involves different types of alternatives, depending on the theory, see more discussion below. Crucially, this reading requires more than just interpreting disjunction as strong (meaning 'either or'). It thus functions as a methodological test case of what it is that is primed with the scalar cases, a new meaning of 'or', or the exclusion of scalar alternatives more generally. For that purpose, we will look into the effects of training with cases like (1) and (2) on these complex sentences.

Our main finding is that priming across scale types (contextual versus lexical) is only one-directional: priming with exclusive readings of disjunction affects strengthened meanings of focus, that is the exclusion of contextual alternatives. However, the converse does not hold. Priming participants to interpret focus strongly does not affect their interpretation of (simple) disjunctions. This suggests that alternative types have different activation thresholds. For theories of implicature, it means that they must distinguish between contextual and scalar cases, at least for disjunction.

The paper is structured as follows: in Section 2, we lay out the theoretical and experimental background relevant for the study reported. Section 3 then reports the priming experiment we conducted. In Section 4, we discuss the consequences of our main experimental findings, both for theories and models of pragmatic strengthening. Section 5 concludes the paper.

2 Background

There are two dominating issues in the theoretical and experimental literature on quantity implicatures. They concern the exact nature of the strengthening mechanism, and the role of alternatives therein. These issues are intricately linked, both theoretically and experimentally. On the theoretical side, different alternative-generating mecha-

nisms have been shown to produce diverging results for strengthening (Franke, 2011; Spector, 2016). On the experimental side, alternatives have been shown to determine when the process is activated (Degen and Tanenhaus, 2015; Rees and Bott, 2018; Waldon and Degen, 2020).

Theories can be categorized across two dimensions, namely whether they assume uniformity of alternatives, or uniformity of mechanism, or both, see (4) and (5).

(4) **Uniformity of mechanism/operator** There is a single mechanism behind all pragmatic strengthening (involving lexical and contextual scales).

(5) **Uniformity of alternatives** Alternatives are derived in a unified manner for contextual and scalar alternatives.

The aim of the paper is to study these two hypotheses in combination, rather than in isolation, thereby informing models of strengthening and theories alike.

2.1 Theoretical background

Most theories assume and postulate uniformity of both alternatives and strengthening mechanism. They do differ in the detailed assumptions about what sources of alternatives there are, however, and what the algorithm for their derivation is. To illustrate, consider again the three cases of disjunction, focus and complex 'and-or'-sentences introduced above in schematic form (6) to (8).[1]

(6) context: $\{a, b\}$

    a. $a \vee b$
       'a or b'   DISJUNCTION

    b. S-M of (6a) $= (a \vee b) \wedge \neg(a \wedge b)$
       'a or b but not both a and b'

(7) context: $\{a, b\}$

    a. a   FOCUS
       'a'

    b. S-M of (7a) $= a \wedge \neg b$
       'a and not b'

(8) context: $\{a, b, c\}$

    a. $(a \wedge b) \vee c$ AND-OR
       'a and b, or else c'

    b. S-M of (8a) $= (a \wedge b \wedge \neg c) \vee (c \wedge \neg a \wedge \neg b)$
       'a or b and not c, or else c and not a and not b'

Theories differ in how they get to the strengthened meanings in (6b), (7b), and (8b). According to the classical Gricean view (Grice, 1975), the mechanism behind strengthening is abductive reasoning over more informative things the speaker could have said. What these things, the alternatives, are, is considered highly context dependent and not

---

[1]We use S-M for strengthened meaning, to stay theory neutral regarding the nature of the mechanism.

formally derived. In addition, the mechanism is taken to be a global one, operating on the level of utterances.[2]

Under a grammatical approach to implicatures, the mechanism of strengthening is a covert syntactic operator. It can occur locally and can be obligatory (Chierchia et al., 2012; Chierchia, 2013; Magri, 2009). This operator takes a set of alternatives *Alt* and a proposition *p* and excludes those propositions in *Alt* that are not entailed by *p*. Its lexical meaning is thus very similar to the exclusive particle 'only' (*modulo* presuppositions). There exist two versions of this operator, one working with minimal models (EXH_{mm}) (Groenendijk and Stokhof, 1984; Van Rooij and Schulz, 2004; Schulz and Van Rooij, 2006; Spector, 2007) and one working with innocent exclusion (EXH_{ie}) (Fox, 2007) (for a more detailed comparison see Franke (2011); Spector (2016)). Spector (2016) shows that they differ in what alternatives they need to consider (for the exact alternatives considered see Appendix A.1). A theory working with EXH_{mm} distinguishes between scalar and contextual cases insofar as the alternatives for scalar cases are built from what is given in the sentence. To build models for the contextual case, the context must be considered.

Spector (2016) shows that the EXH_{ie} version of the operator will be vacuous for disjunction under the assumption of minimal alternatives.[3] The operator EXH_{ie} is associated with another view on alternatives, where a limited set of operations—substitution, replacement, deletion—derive alternatives from a given structure (Katzir, 2007; Fox and Katzir, 2011). The mechanism is argued to be the same for generalized and particularized conversational implicatures. However, *what* is replaced or substituted differs in extant accounts (see Appendix A.2 for details).

The two grammatical views just sketched thus assume uniform alternatives and mechanism. However, both leave room to distinguish between contextual and scalar alternatives, as *how* they are derived slightly differs.

Another view to consider is offered by Geurts (2010). He generally assumes a Gricean reasoning mechanism to be active in quantity implicatures. However, he considers disjunction to be a special case. He argues that it implies that 'the speaker does not know *a*' and 'the speaker does not know *b*'. As a result, it makes little sense to think about the speaker uttering the conjunction of both he claims. The resulting inference, according to this view, is not an implicature but just an assumption based on the contextual probability of both disjuncts being true in a given context. Thus, no quantity-based reasoning is involved in this case at all and as such it should be distinguished from cases where contextual alternatives are clearly considered.

In sum, there is an ongoing theoretical debate about which, if any, alternatives are relevant to pragmatic strengthening involved in disjunction and focus. The theories differ with respect to whether they assume a uniform mechanism of derivation of alternatives and their exclusion to be active for both generalized and particularized conversational implicatures.

---

[2]The so-called neo-Gricean view postulates local application of this mechanism (Sauerland, 2004). As the current paper is not concerned with the issue of locality, we will not get into more detail regarding these theories.

[3]His main point is that the two operators are equivalent if alternatives are closed under conjunction.

2.2 Experimental background

There is a vast experimental literature on different processing predictions of a grammatical versus more Gricean view of implicatures. Grammatical theories are often taken to predict a default process (*default* view), where the implicature is always derived but canceled if context requires it. The Gricean view is associated with the prediction that the literal meaning is accessed first, and enriched if context requires it (*Literal first* view). There is both evidence for the strengthened meaning to be less costly, thereby supporting a default model (Grodner et al., 2010), and for the literal meaning being less costly, supporting a Literal-first model (Noveck and Posada, 2003; Bott and Noveck, 2004; Breheny et al., 2006; Huang and Snedeker, 2009, 2011; Bott et al., 2012). Evidence from mouse-tracking suggest a hybrid model for strengthening where it proceeds in two steps, with the literal meaning being accessed first (Tomlinson Jr et al., 2013).

More recently, the importance of salience and relevance of alternatives has been demonstrated experimentally (Breheny et al., 2013; Chemla and Bott, 2014; Degen and Tanenhaus, 2015; Bott and Chemla, 2016; Gotzner et al., 2016; Van Tiel and Schaeken, 2017; Rees and Bott, 2018; Waldon and Degen, 2020). A first observation is that not all constructions for which alternatives have been postulated give rise to the same processing delays. Secondly, for certain processes the alternatives provided by the context play a role in delaying or facilitating the process. Before we move on to discuss our experiment showing how the presence of alternatives might prime strengthening within the same scale type versus across different scale types for the case of disjunction and focus, we will briefly summarize previous experiments looking at how different expressions that are standardly assumed to evoke alternatives influence the process of strengthening.

Degen and Tanenhaus (2015) report three different experiments using sentence verification tasks on the scalar implicature associated with 'some' ('some but not all'). Their results show that both the size of the domain and the presence of numerals as possible alternatives influence the rate of implicatures. They propose a constraint-based model, which predicts that the process of deriving the implicature can be sometimes delayed and sometimes immediate, depending on whether the right contextual conditions are met. They identify the presence and relevance of the right alternatives—as, for example, evoked by a contextual question—as one such condition. They suggest that the difference between generalized and particularized conversational implicatures need not be rooted in a difference in the mechanisms involved, but rather different constraints on activation. This model reflects both the more complex theoretical issue of activation of the mechanism and its interaction with alternatives outlined above, as well as the conflicting empirical findings on delays.

Chemla and Bott (2014) present results from reaction time studies with sentence verification tasks showing that scalar implicatures associated with 'some' and free choice inferences associated with disjunction display different behaviour. They argue that this does not speak against assuming the same underlying mechanism for both inference types but could be rooted in the fact that the generation of alternatives works differently for the two cases. To derive the implicature of sentences with 'some', the lexical alternative 'all' has to be accessed. However, in the case of disjunction the alternatives are found within the sentence. In a priming experiment, Bott and Chemla

(2016) show that there is priming across scalar (involving 'some' and numerals) and contextual domains, suggesting that they share part of the enrichment process. They find that inferences associated with plural expressions behave differently, however. They consider different explanations for this; one based on the search for proper alternatives being shared (or not), the other being that the exclusion mechanism itself is primed (or not).

Van Tiel and Schaeken (2017) use picture verification tasks with abstract shapes to investigate the processing of inferences associated with scalar 'some', free choice disjunction, if-clauses (conditional perfection) and it-clefts (exhaustivity). They found that clefts and conditional perfection examples patterned with free choice inferences, which differed from the scalar cases involving 'some', in line with the findings of Chemla and Bott (2014). They argue that this supports a *lexical access* view of scalar implicatures, where it is the accessing of the lexicalized scalar alternative that causes delay in decision times.

Rees and Bott (2018) tested the influence of alternatives in implicatures associated with contextual scales (existential constructions) versus lexical scales ('some' and numerals) in a priming study using a similar paradigm as Bott and Chemla (2016). They found that the presence of the alternative itself primed exclusion mechanisms. Based on these findings, they argue for a *salience model* of pragmatic strengthening, in contrast to a *combined model*. The latter is a two-step model which assumes that activating alternatives and activating a mechanism for their exclusion are discrete steps. Both are triggered independently and a certain activation threshold has to be met for each. The former is a simpler, one-step model which assumes the activation of the alternative to be the threshold for activating exclusion. As soon as the threshold for activating the alternative is met, the strengthening mechanism itself (exclusion of the alternative) will be triggered. The two models are depicted in Figure 1.

In view of their results, they revisit the theoretical options discussed by Bott and Chemla (2016) and argue that the priming observed across domains was probably due to a search for alternatives activated in both processes. They find that contextual scales differ slightly from lexical scales and suggest that this may be due to higher activation thresholds. This contrasts in part with the processing results found by Van Tiel and Schaeken (2017), where the exhaustivity inferences associated with it-clefts led to lower reaction times than scalar implicatures associated with 'some'. More recently, Waldon and Degen (2020) partially replicated the findings of Bott and Chemla (2016) and Rees and Bott (2018). Employing the same priming paradigm, they again find evidence for weak and strong priming of scalar inferences associated with different expressions (numerals, existential expressions, and 'some'). As Rees and Bott (2018), they find that exposure to their respective 'canonical' alternatives modulates scalar inferences.[4] In addition to the influence of canonical alternatives, they also tested the influence of alternatives including overt 'only' and alternatives including explicit negation of the stronger expression ('some but not all', 'four but not more than four', 'there is a triangle but nothing beside a triangle'), which, under most theories, are not considered formal alternatives on account of being 'asymmetric' to the original utterance (see Fox, 2007; Katzir, 2007; Fox and Katzir, 2011). They find that exposure to these

---

[4]But unlike Rees and Bott (2018) they do find differences between *strong* and *alternative* primes.
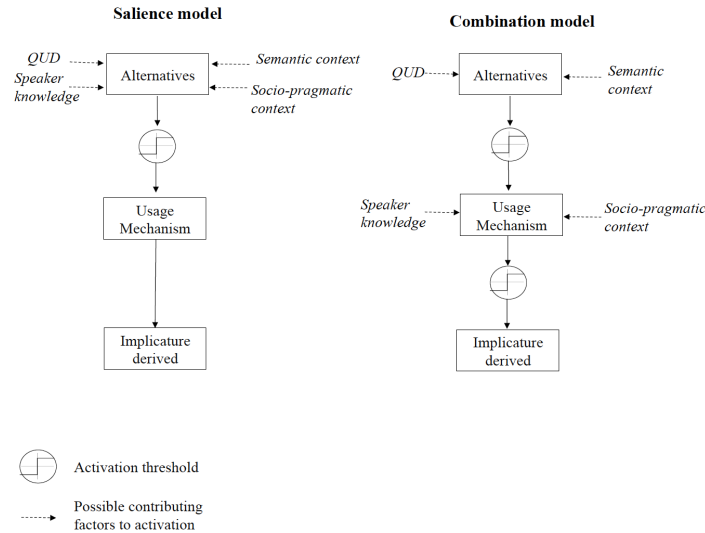
Figure 1: Two models for a strengthening mechanism.

alternatives also modulates scalar inferences. They suggest this to mean that participants can access strengthened meanings of given scalar expressions when exposed to them in strong priming groups and when exposed to the canonical alternatives they are based on. However, they also propose that participants can adapt their interpretation of utterances to the linguistic expressions used as alternatives in the context.

In sum, the experimental literature suggests that whether pragmatic enrichment is an immediate/cheap or delayed/costly process depends also on the presence of alternatives. The evidence presented partly supports a view where the type of alternative, whether it is accessed lexically or via the context, influences the strengthening mechanism. Recent results from priming suggest that activation of the right alternatives is enough to activate enrichment, but that the activation threshold may be different for contextual and lexical alternatives. The aim of our experiment is to further investigate the role of contextual versus lexical scales in activation of the mechanism. Based on our findings, we propose a refinement of the *salience model*. In this model, activation of alternatives is enough to activate the mechanism, but the activation threshold is different for contextual and lexical scales. Crucially, both will be combined when the mechanism is applied. Thus, priming across scale types is only predicted when there is overlap between the two (as is the case in our experiment). The priming paradigm used deviates from previous priming paradigms in that it explicitly introduces a speaker and allows for manipulating the contextual question. It thus allows for testing predictions of existing models in "a more naturalistic setting" (Waldon and Degen, 2020, p. 127). Furthermore, it includes two cases which have not been looked at previously: complex disjunctions, and simple focus sentences (not involving existential or cleft constructions).

3 Experiment

We designed a feedback-based priming experiment to (a) test the influence of quantity implicatures associated with simple disjunction and focus on each other and (b) test the influence of both on scalar cases involving 'and-or' (complex disjunction). The main aim of the experiment was to test the predictions of different theories regarding what alternatives and mechanisms are involved. A second goal was to test whether exposure to the alternative is sufficient to activate strengthening, or activation of the mechanism is needed independently, thereby further testing the two models of strengthening articulated by Rees and Bott (2018).

3.1 Procedure

The experiment proceeded in two steps: a priming and a probing phase. During the first phase, participants were primed with feedback-based training to either accept weak or strong readings of different simple sentences involving focus or disjunction. More details on the different priming groups and the exact feedback they received are given below. During the probing phase, people judged simple sentences involving disjunction or focus, and more complex sentences involving 'and-or'. They did not receive feedback on their responses in this second phase. The general idea behind this two-step procedure was to prime participants for certain readings of a given sentence type and then test the influence of this training-based priming on different (weak and strong) readings of a new sentence type that they did not encounter during training.

For the priming phase, participants were instructed that the experiment was about a guessing game in which someone predicts what, if any, of the shapes that would appear on the screen are red. Their task was to decide whether the prediction was accurate given the picture they saw. They were told that they would be given feedback on their decisions in the first half of the experiment. Phrasing instructions and framing the experiment in terms of a guessing game served two purposes. First, making clear that the predictions were about the question "What is red?" clarified and fixed the focus of all sentences to whatever was described as red. Second, describing the sentences as guesses made disjunctions felicitous. As we pointed out above, disjunctions come with the inference that the speaker is ignorant with regard to which of the two disjuncts is true. If the person uttering a sentence had visual access to the picture, a disjunction would always be under-informative as it is clear to that person which of the shapes is red. However, in a guessing scenario the ignorance with regard to which of the shapes is red becomes perfectly reasonable. Thus, we expected participants to not make additional assumptions regarding how co-operative or reliable a speaker is. To make this set-up clear to the participant, the target sentence was preceded by 'Someone predicts:' for each trial. The picture showing different shapes appeared after a delay of 1500ms. A sample of what a trial looked like is given in Figure 2 below.

3.2 Design and participants

The independent variables of the experiment were PRIMING TYPE (Were they primed with sentences involving focus or disjunction?) and PRIMING STRENGTH (Were they

Someone predicts:

The square and the circle and the triangle are red.

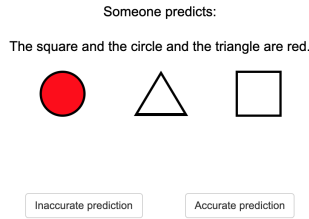| Inaccurate prediction | Accurate prediction |

Figure 2: Sample priming trial

trained to accept weak or only strong readings of focus or simple disjunction?). These levels were fully crossed to yield the following conditions, that is priming groups: FOCUS-STRONG, FOCUS-WEAK, DISJUNCTION-WEAK, DISJUNCTION-STRONG. The dependent variable was rate of 'no-responses' to critical primes. Saying 'no' is an indication of the relevant strong readings, see the materials below. We were interested in whether priming affected the stability of these readings and how. We recruited 200 participants via Prolific. They received what Prolific labelled 'good' pay for taking the experiment (7.50GBP/h). The actual average pay exceeded this amount, as most participants were quicker than the estimated time they were allotted (11GBP/h).

3.3 Materials

3.3.1 Primes

Participants were confronted with different sentence types in the priming phase, depending on which priming group they were in. In total there were four priming groups, two primed with disjunctions (group 1 and 2) and two primed with focus sentences (group 3 and 4).

Participants in groups 1 and 2 were primed with strong and weak readings of disjunction (PRIMING TYPE = DISJUNCTION), that is they saw critical sentences such as (9) in addition to control sentences described below. The weaker, inclusive, reading of disjunction is paraphrased in (9a), its stronger, exclusive, reading in (9b).

(9)   The triangle or the square is red.   SIMPLE DISJUNCTION

    a.   *The triangle or the circle is red, possibly both.*   INCLUSIVE READING
    b.   *The triangle or the circle is red but not both.*   EXCLUSIVE READING

Sentences were paired with picture types that falsified these different readings, see Table 1. Numbers in brackets indicate occurrences in the priming phase.

Within the participants that were primed with disjunction there was a strong and weak priming group (PRIMING STRENGTH = weak/strong). The feedback differed for these groups: whereas participants in the weak group got positive feedback if they said "accurate" to disjunctions that falsified the exclusive reading, participants in the strong group got negative feedback if they said "accurate" in this case. Both groups should say "accurate" in the exclusive case (which is true under any reading) and "inaccurate" to

sentence	picture	false under...
The triangle or the square is red. (6)		exclusive reading
The triangle or the square is red. (3)		no reading
The triangle or the square is red. (3)		any reading

Table 1: Readings of disjunctive sentences

cases that falsified any reading and received feedback accordingly. The full response-feedback matrix is given in Appendix B.

Participants in groups 3 and four 4 were trained with strong and weak readings of sentences such as (10a) and (10b) (PRIMING TYPE = FOCUS).

(10) a. The triangle is red.   FOCUS SIMPLE
      b. The triangle and the square are red.   FOCUS CONJUNCTION

For these sentences, there are two possible readings. The weaker 'at-least' readings in (11a) and (12a), respectively, which allow other things to be red than the ones mentioned in the sentence, and the stronger 'only'-readings (exhaustive readings) paraphrased in (11b) and (12b), respectively.

(11) The triangle is red.   FOCUS SIMPLE
      a. *The triangle is red and possibly something else is.* AT-LEAST-READING
      b. *The triangle is red and nothing else is.*   ONLY-READING

(12) The triangle and the square are red.   FOCUS CONJUNCTION
      a. *The triangle and square are red and possibly something else is.*
                                                                         AT-LEAST-READING
      b. *The triangle and square are red and nothing else is.*   ONLY-READING

For the focus groups, sentences were paired with pictures where other items than the one in focus were red, making the weak reading true and strong reading false, or paired with pictures where the item(s) in focus were the only red thing, making the weak and strong reading true. To prevent participants from developing strategies based on specific picture types, we varied how many other (non-)red shapes there were. The sentence-picture pairings we used are given in Table 2. There were in total 6 pictures making the at-least reading true, 3 pictures making the 'only' reading true and 3 falsifying the sentence under any reading. Numbers in brackets indicate occurrences in the priming phase.

Within the groups primed with focus, there was also a strong and a weak priming group (PRIMING STRENGTH = weak/strong). The strong priming group received negative feedback when saying "accurate" to picture conditions that falsified the strong reading. The weak group received positive feedback when saying "accurate" to these sentence-picture pairings. Participants in all groups should say "accurate" in trials that verified any reading and "inaccurate" to sentence-picture pairing that falsified any read-

sentence	picture	false under...
The triangle is red. (2)	▲(red) ■(red)	only-reading
The triangle is red. (1)	▲(red) □(white)	no reading
The triangle is red. (1)	△(white) ■(red)	any reading
The triangle is red. (2)	▲(red) ■(red) ○(white)	only-reading
The triangle is red. (1)	▲(red) □(white) ○(white)	no reading
The triangle is red. (1)	△(white) ■(red)	any reading
The triangle and the square are red. (2)	▲(red) ■(red) ●(red)	only-reading
The triangle and the square are red. (1)	▲(red) ■(red) ○(white)	no reading
The triangle and the square are red. (1)	△(white) ■(red) ●(red)	any reading
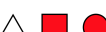
Table 2: Readings of focus sentences

ing (and were given feedback accordingly). The full response-feedback matrix can be found in Appendix B.

3.3.2 Probes

Probe items were the same for all groups of participants. The first kind of probe items included the same sentences as used in the priming phase described above, repeated in (13a) to (13c) below.

(13)   a.   The triangle is red.   FOCUS SIMPLE
       b.   The triangle and the square are red.   FOCUS CONJUNCTION
       c.   The triangle or the square is red.   SIMPLE DISJUNCTION

In the probing phase, sentences with disjunction only appeared in picture conditions that falsified the exclusive reading. Sentences with focus appeared only in picture conditions that falsified the 'only'-reading. Furthermore, probe items contained complex sentences with both conjunction and disjunction. This sentence type was thus new to all participants. Complex 'and-or' sentences are associated with three types of readings, the weak reading (14a), the intermediate reading (14b), and the strong reading (14c).

(14)   The triangle and the circle are red, or else the square is.   COMPLEX DISJUNCTION

       a.   *The triangle and the circle are red, or the square is, or possibly all three of them are.*   WEAK READING
       b.   *The triangle and the circle are red, or else the square is but not all three are.*   INTERMEDIATE READING
       c.   *Either the triangle and circle are red but the not the square, or the square*

The complex 'and-or' sentences appeared in five different picture conditions: one falsifying any reading, one falsifying only the intermediate reading, one falsifying the strong reading, and two verifying any reading.

Examples of the picture conditions in which the critical sentences appeared in the probing phase are given in Table 3. The number in brackets indicates how often the condition appeared in the probe phase.
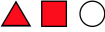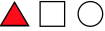
sentence	picture	false under...
The triangle is red. (3)	▲🟥 (red triangle, red square)	focus 'only' reading
The triangle or the square is red. (3)	▲🟥 (red triangle, red square)	exclusive reading
The triangle and circle are red, or else the square is. (4)	▲🟥○ (red triangle, red square, empty circle)	strong reading
The triangle and the square are red, or else the circle is. (4)	▲🟥● (red triangle, red square, red circle)	strong/intermediate reading
The triangle and the square are red, or else the circle is (2).	▲🟥○ (red triangle, red square, empty circle)	no reading
The square and the circle are red, or else the triangle is. (2)	▲□○ (red triangle, empty square, empty circle)	no reading
The triangle and the square are red, or else the circle is. (4)	▲□○ (red triangle, empty square, empty circle)	any reading

Table 3: Probe items

Which groups of participants saw which sentence in which picture conditions during the prime and probe phase is summarized schematically in Figure 3.

3.3.3 Controls

There were simple and complex sentences (with up to two conjunctions) in verifying/falsifying picture conditions, see Table 4. There were 18 controls of this kind, 9 in the prime, 9 in the probe phase (3 true, 6 false).

In total, there were 9 controls in the prime phase plus 12 critical primes per group (21 trials in prime phase). There were also 9 controls in the probe phase and 8 complex true/false controls with 'and-or' ('yes'/'no'-control-probe). In addition, there were 14 critical probes in the probe phase (31 trials in probe phase). Overall, there were thus 52 trials.

For all items the order of symbols was randomized, i.e. they did not necessarily match the order of symbols as they were mentioned in the sentence. Which of the items appeared as red was pseudo-randomized. The goal was to include as much as
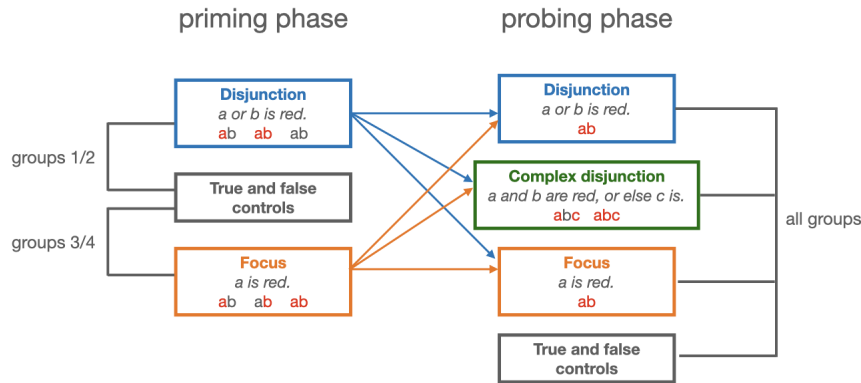
priming phase   probing phase

Disjunction
a or b is red.
ab   ab   ab

Disjunction
a or b is red.
ab

groups 1/2

True and false
controls

Complex disjunction
a and b are red, or else c is.
abc   abc

all groups

groups 3/4

Focus
a is red.
ab   ab   ab

Focus
a is red.
ab

True and false
controls

Figure 3: Priming procedure schematic

sentence	true	false
The triangle is red.	▲	△
The triangle and the square are red.	▲■	▲□
The triangle and the square and the circle are red.	▲■●	▲■○, ▲□○

Table 4: True and false control sentences

variability as possible, so that nothing could be predicted from the form of the sentence or the picture alone.

3.4   Analysis

Of the 199 participants (native speakers of English) recruited via Prolific we excluded 9 participants from the analysis, 5 of which answered fewer than 90% percent of true and false controls in the priming phase correctly, 4 did not change their behaviour for critical primes (consistently said the opposite of what they were primed for).

The remaining data from 190 participants were analysed using generalized linear mixed effect models with the `lme4` package in R. The dependent variable was rate of 'no'-responses, as saying 'no' indicated the presence of a reading. The critical sentence types and which picture conditions they appeared in the probe phase are given in Table 5.

Saying 'no' to the picture for simple disjunction reflects the exclusive reading. Saying 'no' to the two focus sentences reflects the 'only'-reading. We looked at two read-

sentence type	sentence	picture
simple disjunction	'a or b is red'	a b
focus	'a is red'/'a and b are red'	a b / a b c
complex disjunction (1)	'a and b are red, or else c is'	a b c
complex disjunction (2)	'a and b are red, or else c is'	a b c

Table 5: Critical sentence-picture pairings used in the probe phase.

ings of complex disjunction, the first (1) picture type falsifies the intermediate reading, where disjunction is interpreted exclusively. The second picture type (2) falsifies the strong reading. Table 6 shows which responses are (only) compatible with which readings for the critical sentence and picture conditions.

sentence	picture	response	reading
'a or b is red'	a b	'yes'	inclusive
'a or b is red'	a b	'no'	exclusive
'a is red'/'a and b are red'	a b / a b c	'yes'	'at-least' reading
'a is red'/'a and b are red'	a b / a b c	'no'	'only'-reading
'a and b are red, or else c is'	a b c	'yes'	weak
'a and b are red, or else c is'	a b c	'no'	intermediate/strong
'a and b are red, or else c is'	a b c	'yes'	weak/intermediate
'a and b are red, or else c is'	a b c	'no'	strong

Table 6: Picture conditions and sentences used for each sentence type in probe phase.

To look at the effect of PRIMING STRENGTH (STRONG/WEAK) on different critical probe sentences we first tested for the interaction between SENTENCE TYPE ('yes'-control versus critical probes) and PRIMING STRENGTH for each critical sentence type. We assumed there to be a general 'no'-bias for the strong priming groups. If the effect of PRIMING STRENGTH is not just due to this bias we predict there to be an interaction. To test for the presence of an interaction we used nested model comparisons via log likelihood ratio tests. For all models, we included random slopes for participants for the within-participants factor SENTENCE TYPE.[5] We compared a model with the interaction term GLMER(RESP ∼ SENTENCE*CONDITION + (1+SENTENCE |SUBJECTID) to a model without it GLMER(RESP ∼ SENTENCE+CONDITION + (1+SENTENCE | SUBJECTID). We calculated the f-square value as an indicator of effect size with the `effsize` package in R. Results of these model comparisons for each relevant prime and sentence type are summarized in Table 7. The interaction between SENTENCE TYPE and PRIMING STRENGTH were significant for all sentence types except when priming type was disjunction and probe sentences were (non-exhaustive) focus sen-

---

[5]Participants saw different versions of a given target item in a given condition as shapes and order in which they were mentioned was random. For that reason, we did not include the effect of item in the random effect structure.

tences. These findings indicate that priming strength affected the critical sentences differently from 'yes'-controls except for in this case. Thus, the effect for most critical sentence types was not just due to a bias created by different priming groups to say 'no'. Only for the critical focus sentences the results point to there being no effect of strong priming with disjunction beyond a bias to say 'no'.

probes	disjunction prime	focus prime
simple disjunction	$\chi^2(1) = 37.673\ \mathrm{f}^2 = 0.59$	$\chi^2(1) = 4.7817,\ \mathrm{f}^2 = 0.2$
focus	$\chi^2(1) = 1$	$\chi^2(1) = 70.762,\ \mathrm{f}^2 = 0.35$
complex disjunction (1)	$\chi^2(1) = 6.1781,\ \mathrm{f}^2 = 0.31$	$\chi^2(1) = 4.9088,\ \mathrm{f}^2 = 0.45$
complex disjunction (2)	$\chi^2(1) = 12.256,\ \mathrm{f}^2 = 0.61$	$\chi^2(1) = 6.8175,\ \mathrm{f}^2 = 0.75$

Table 7: Results of model comparisons for interaction of SENTENCE TYPE*PRIMING STRENGTH per PRIMING TYPE (disjunction/focus). Complex disjunction (1) is intermediate reading of the complex disjunction 'a and b, or c'. Complex disjunction (2) refers to the strong reading of complex disjunction.

Figure 4 summarizes the proportion of 'no'-responses by critical SENTENCE TYPE and PRIMING STRENGTH. The results for controls are given in Appendix B.
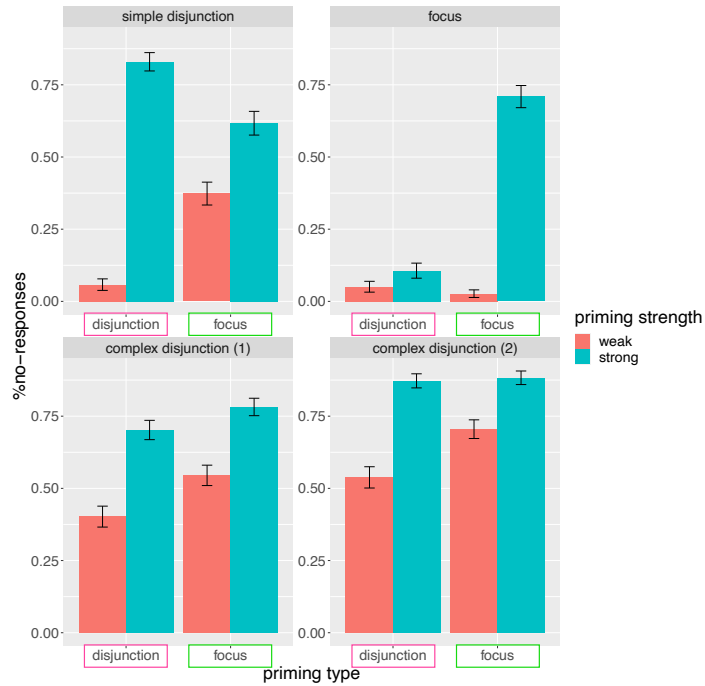

Figure 4: Rate of no-responses in the probe phase by sentence type and priming group. Error bars indicate the standard error.

We then looked at the simple effects of PRIMING STRENGTH for the critical target sentence types disjunction, focus and complex disjunction (1 and 2).[6] Focusing on simple disjunction first, we find a simple effect of PRIMING STRENGTH for both PRIMING TYPES, disjunction and focus (for focus on simple disjunction: $\hat{\beta} = -2.2365$, SE $= 0.7933$, z-value $= -2.819$, $Pr(> |z|) = 0.00482$; for disjunction on simple disjunction: $\hat{\beta} = -6.4922$, SE $= 1.1767$, z-value $= -5.517$, $Pr(> |z|) = 3.44e - 08$). Looking at the focus sentences, we see that there was an effect of PRIMING STRENGTH on focus sentences only when the priming type was focus (simple effect of focus on focus sentences:$\hat{\beta} = -16.634$, SE $= 2.979$, z-value $= 5.583$, $Pr(> |z|) = -2.36e - 08$), not when it was disjunction ($\hat{\beta} = -1.01638$, SE $= 2.22931$, z-value $= -0.456$, $Pr(> |z|) = 0.648$).

Focusing on the two types of complex disjunction next, we find that both readings of complex disjunction are affected by priming strength for both priming types (disjunction and focus). There was a simple effect of disjunction on the strong reading of complex disjunction ($\hat{\beta}$= -4.2610, SE=1.0955, z value= -3.890, Pr($> |z|$)= 0.00010), and a simple effect of focus on the strong reading of disjunction ($\hat{\beta}$= -2.0454, SE=0.7452, z value=-2.745, Pr($> |z|$)= 0.00605). There was also a simple effect of disjunction on the intermediate reading of complex disjunction ($\hat{\beta}$= -4.0619, SE=1.2570, z value= -3.231, Pr($> |z|$)= 0.00123) and simple effect of focus on the intermediate reading of complex disjunction ($\hat{\beta}$= -3.758, SE=1.412, z value=-2.661, Pr($> |z|$)= 0.00779).

To see whether the priming effect on different sentence types was was more or less effective with a specific PRIMING TYPE, we further looked at the interaction of PRIMING STRENGTH with PRIMING TYPE for simple disjunction, focus and the two types of complex disjunction. We did this by comparing a model with the interaction term GLMER(RESP $\sim$ STRENGTH*PRIMING_TYPE + (1 |SUBJECTID) to a model without one GLMER(RESP $\sim$ STRENGTH+PRIMING_TYPE + (1 | SUBJECTID) using nested model comparisons via log likelihood ratio tests. The model comparison revealed that the interaction term is justified for focus ($\chi^2(1) = 12.985$) and for simple disjunction ($\chi^2(1) = 29.843$). We calculated contrasts based on least square means using the emmeans package in R. We see that, for focus, strength only mattered for focus primes ($\hat{\beta}$=-17.487 , SE=2.56, z value=-6.834, Pr($> |z|$) $<$.0001), but not for disjunctive primes ($\hat{\beta}$= -1.026, SE=2.04, z value=-0.502, Pr($> |z|$)= 0.6154). For disjunction, strength played a role for focus primes ($\hat{\beta}$=-2.08, SE=0.692, z value=-3.008, Pr($> |z|$) =0.0026) and disjunctive primes ($\hat{\beta}$=-7.60, SE= 1.035, z value=-7.342, Pr($> |z|$) $<$.0001), but, as numerical differences suggest, a bigger role with disjunction than focus, i.e. internal priming was more pronounced. The interaction term was not justified for the intermediate reading of complex disjunction ($\chi^2(1) = 0.3757$) or the strong reading of complex disjunction ($\chi^2(1) = 2.2492$), suggesting that they were equally affected by strength for both types of the priming.

---

[6]Intercept levels were always the relevant sentence type and strong priming group. The simple effect of priming group should thus affect proportion of 'no'-responses negatively as fewer 'no'-responses indicate fewer strong readings.

3.5 Summary

Overall, we find that focus priming affects all sentence types: it primes 'only' readings of focus (internal priming) and strong readings of complex and simple disjunction. However, the converse does not hold. Training participants to interpret disjunction as exclusive primes strong(er) readings of simple and complex disjunctions (internal priming), but not strong readings of focus.

4 General Discussion

We investigated the role of different types of priming on strong readings of focus sentences, as well as simple and complex disjunctions. We found that priming participants to interpret focus sentences strongly using feedback-based training made them more likely to strengthen all types of disjunction. Training participants to interpret simple disjunctions exclusively carries over to a strong interpretation of complex disjunctions (showing that they did not simply learn that 'or' meant 'either or'), but it does not make them more likely to get 'only'-readings of focus sentences. That is, we find one-directional priming across alternative types: focus (involving contextual alternatives) primes strengthening of disjunction, but not the converse.

First, our results speak against a completely uniform view of mechanisms and the alternatives they act upon. If the mechanisms and the alternatives were uniform across contextual and lexical cases, we would see priming of focus-strengthened meanings with exclusive disjunctions. We observed no such effect. What we did find was priming of stronger readings of both types of disjunction with strengthened meanings of focus, and thus our findings are also problematic for theories that propose entirely independent mechanisms and alternatives for the two cases.

Second, our data are puzzling for views where exclusive readings of disjunctions do not involve pragmatic reasoning of any kind (Geurts, 2010). The fact that strengthened focus *does* prime strong readings of disjunction is entirely mysterious for such approaches.

As mentioned above, the fact that priming with simple disjunction affects both simple and complex disjunction entails that it is not just an interpretation of 'or' as 'either or' that is being primed in our study. This is because the observed readings of complex disjunction cannot be generated simply by interpreting disjunction as an exclusive disjunction. Instead, our results suggest that a particular mechanism for deriving scalar alternatives is being primed. Our results are compatible with individual alternatives being relevant and generated for both kinds of disjunction — $\{a,b\}$ for simple and $\{a,b,c\}$ for complex disjunction (Van Rooij and Schulz, 2004) — and with a powerful syntactic substitution mechanism for generating alternatives (Katzir, 2007; Fox and Katzir, 2011). This in itself does not speak for or against a specific type of exclusion mechanism: for each mechanism on the market, there is a set of alternatives that generates the relevant readings.

A more promising route to explaining the fact that there is one-directional priming between focus and disjunction is that the same mechanism is involved, but fails in the absence of the right alternatives in one case. In terms of a structural view of alter-

natives, one explanation in line with our data is that substitution of scalar terms did not prime replacement of lexical material, but replacement of lexical material made substitution of scalar terms more salient. Or, in the terms of a minimal model view, accessing contextual alternatives to build the model can prime accessing scalar ones, but not the converse. One reason may be that lexically accessing the 'and' alternative is hard(er) (Breheny et al., 2013; Van Tiel and Schaeken, 2017), but already facilitated by contextual search for alternatives, especially since these involve complex alternatives of the right form (*a and b*). However, lexically accessing the alternative need not be a context-dependent process, and thus may not facilitate the context search involved in deriving focus effects. However, this kind of distinction speaks against the exact derivation mechanism proposed by Fox and Katzir (2011). Crucially, the advantage of that proposal is that structural and contextual alternatives are considered at the same time for both, and are subject to the same constraints. The results presented rather speak in favour of one being a special case of the other.

Support for a view that distinguishes between the activation of contextual versus scalar alternatives comes from a recent acquisition study (Gotzner et al., 2020) showing that 4–5 year old children calculate quantity implicatures with contextual alternatives to a higher degree than scalar implicatures with disjunction. They suggest that contextual cases do not necessarily require access to scales, which is in line with our findings in the case of adults. They furthermore argue that disjunction allows for construction of sub-domains more easily than conjunction based on the fact that children calculate more focus implicatures based on the former than the latter. This contrasts with our data, as, contrary to what Gotzner et al. (2020) find for children, disjunction did not facilitate search for domain alternatives for adults.

Our findings are in line with a simple *salience model* (Rees and Bott, 2018), in which the activation of alternatives and mechanism proceeds in one step. Our data offer a more fine-grained view on the *salience model*, however. They suggest that it is not just the activation of the relevant, salient alternatives to be excluded themselves, but rather a specific *mechanism* for deriving alternatives that needs to be activated. The strategies for deriving and establishing relevant alternatives differs between contextual and scalar cases, as the former but not the latter requires a context search (for domain alternatives). Specifically, we would like to propose the model in Figure 5, where contextual and scalar alternatives come with different activation thresholds. However, both are considered for the usage mechanism triggered.

In the case of disjunction, the search for sentence internal alternatives (S-alternatives) is activated, and with them a mechanism of excluding these alternatives. As a result, they prime deriving the relevant S-alternatives for both simple and complex disjunctions. However, the threshold for activating C-alternatives was not met (contextual alternatives are not relevant). Thus, deriving the right alternatives for the contextual cases was not primed. However, in the case of focus primes, contextual alternatives (provided by the picture) are activated. For the scalar cases under consideration the alternatives within the sentence are the same as in the context, that is for the sentence 'a or b is red' the relevant alternatives {a,b} are both present in the sentence *and* the picture (context). As a result, priming with focus affects and primes scalar cases as well as focus cases.

Our findings suggest that exposure to sentences containing relevant alternatives

Speaker knowledge ┄┄▶ | S-Alternatives | | C-Alternatives | ◀┄┄ *Semantic context*

QUD ┄┄▶ | | | | ◀┄┄ *Socio-pragmatic context*

Alternatives =
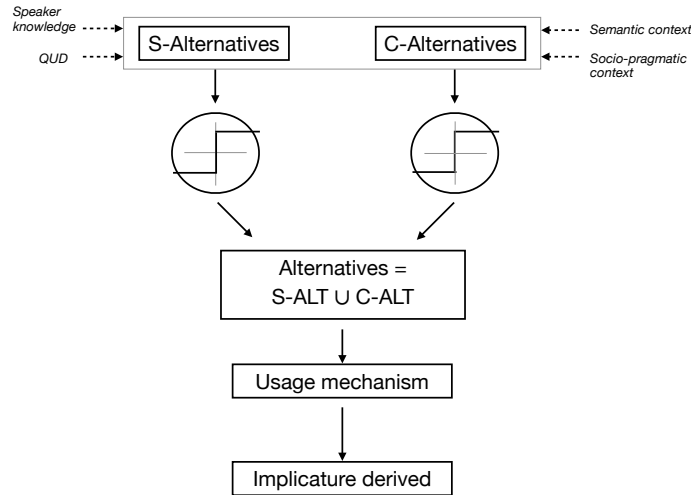S-ALT ∪ C-ALT

Usage mechanism

Implicature derived

Figure 5: New model for strengthening

is not sufficient to meet the activation threshold for contextual cases (all participants were exposed to these alternatives). Rather, contextual pressure (such as our feedback) is needed to make the consideration of sentence-external alternatives provided by the picture relevant. The global question "What is red?", which was stable across groups, was not enough to meet the threshold.

Much like the results of Rees and Bott (2018), these findings shed new light on the priming results found in Bott and Chemla (2016), who also find that the rates of inferences for contextual scales were overall lower. Moreover, they find a bigger effect of internal (within category) than external (across categories) priming. They do find priming effects across scalar and contextual cases for numerals and 'some'. However, unfortunately, they conflate both directions (lexical → contextual, contextual → lexical) in their analysis. From the raw numbers they give, it looks like they found priming in both directions, as opposed to what we report here. A crucial difference is that for their scalar cases the alternatives cannot be found sentence internally, as is the case for disjunction. Furthermore, there may be different alternatives for 'some' depending on which quantified expressions are used and made salient in the experiment (Degen and Tanenhaus, 2015). To test this hypothesis and the predictions of the model further, a direct comparison of different scalar cases is needed. Another possibility is to make the domain alternatives for focus explicit in the sentence, e.g. with 'Among the circle, square and triangle, the triangle is red'.

5 Conclusion

We offered a more fine-grained model of the roles of alternatives in pragmatic strengthening. We presented data from a priming experiment that tested the involvement of dif-

ferent types of alternatives, scalar and contextual, on different strengthened meanings associated with focus, as well as simple and complex disjunction. We find that priming between the two cases works only in one direction. There is no priming effect of disjunction from focus. Our data allow for novel insights regarding the right notion of alternatives for particularized and generalized conversational implicatures. They also shed new light on existing models of pragmatic strengthening. Furthermore, we established a new priming methodology, which allows for making explicit what the relevant question is and play with the intent and knowledge state of the speaker.

A Appendix to theoretical background

This section goes into details regarding the exact alternatives considered for the cases under discussion for different theories. The relevant sentence we look at are simple disjunction, complex disjunction, and focus, the schematic depictions are repeated in (15) to (17) below.

(15)   context: $\{a,b\}$

    a. $a \vee b$
        '*a* or *b*'   DISJUNCTION
    b.   S-M of (15a) $= (a \vee b) \wedge \neg(a \wedge b)$
        '*a* or *b* but not both *a* and *b*'

(16)   context: $\{a, b\}$

    a.   a   FOCUS
        'a'
    b.   S-M of (16a) $=$ a $\wedge \neg$ b
        'a and not b'

(17)   context: $\{a, b, c\}$

    a.   (a $\wedge$ b) $\vee$ c   AND-OR
        'a and b, or else c'
    b.   S-M of (17a) $=$ (a $\wedge$ b $\wedge \neg$ c) $\vee$ (c $\wedge \neg$ a $\wedge \neg$ b)
        'a or b and not c, or else c and not a and not b'

A.1 Alternatives for exh$_{mm}$

For an operator using minimal models the same type of minimal alternatives can be assumed for all three cases above, $\{a,b\}$ for (15) and (16), $\{a,b,c\}$ for (17). The exact models construed differ for the first two cases, however. Disjunction has the models in Table 8, focus has the ones in Table 9.

w_1	w_2
a	$\neg$a
$\neg$b	b

Table 8: Models for disjunction

w_1	w_2
a	a
$\neg$b	b

Table 9: Models for focus

Since neither of the two models is more minimal than the other in Table 8, the results of strengthening is the disjunction of both, i.e. *(a $\wedge \neg$b) $\vee$ (b $\wedge \neg$a)*. For the

second table, it holds that $w_1 < w_2$.[7] We thus derive the S-M $a \wedge \neg b$. There are five different models compatible with the case *a and b, or c*, see Table 10.

w_1	w_2	w_3	w_4	w_5
¬a	a	a	a	¬a
¬b	b	¬b	b	b
c	c	c	¬c	c

Table 10: Models for complex disjunction

w_1, w_3, w_4 and w_5 are all more minimal than w_2. Furthermore, $w_1 < w_3$ and $w_1 < w_5$. However, there are no models more minimal than w_1 and w_4. The strongest reading is the disjunction of both, see (18).

(18)   ((¬a and ¬b) and c) or (a and b and ¬ c)

A.2   Alternatives for exh$_{ie}$

An operator using innocent exclusion requires alternatives derived by deletion or substitution. In the contextual case, it is the lexical content *a* that is substituted (with *b* or *c*, for example), depending on the context. In the scalar case it is the scalar term 'or', whose alternative is specified by the lexicon. One consequence of assuming the operations of deriving alternatives to be restricted in this was is that they can at most be as complex as the sentence they are derived from. For the scalar case, the alternative is derived by substituting the scalar item 'and' with 'or'. However, for the contextual case the lexical item *a* is replaced with the contextual alternative *b*. Conjunction is not part of the alternatives, as *a and b* is more complex. For the complex 'and-or' case, the strongest excludable alternative is *a or b, and c*, see the derivation in (19).[8]

(19)   EXH-IE$_{(a \vee b)c}$((a $\wedge$ b) $\vee$ c) = ((a $\wedge$ b) $\vee$ c) $\wedge$ not((a $\vee$ b) $\wedge$ c)
         ((a $\wedge$ b) $\vee$ c) $\wedge$ (¬ (a $\vee$ b) $\vee$ ¬ c)
         (¬a $\wedge$ ¬b $\wedge$ c) $\vee$ (a $\wedge$ b $\wedge$ ¬ c)

B   Appendix Experiment

In Table 11 below is the feedback given to participants primed with focus sentences by group (weak or strong) and picture-sentence pairings. In Table 12 below is the feedback given to participants by group and picture-sentence pairings for the groups that were primed with disjunctive sentences.

In Figure 6 are the results for the controls.

---

[7]Where '<' stands for 'is more minimal than' and is defined as fewer alternatives being true.

[8]The set of original alternatives considered for this case is much larger, and their derivation raises two issues: one with plausibility given the computational resources necessary to get the right alternatives, the other with intermediate alternative being weaker than the one excluded, see Mascarenhas (2014) for more discussion and details.

sentence-picture(s)	group	response	feedback
The triangle is red. ▲■ , ▲■○	focus-strong	yes	'Wait, that was actually a bad match!'
		no	'Great, that was indeed a bad match'
The triangle is red. ▲■ , ▲■○	focus-weak	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match'
The triangle and the square are red. ▲■●	focus-strong	yes	'Wait, that was actually a bad match!'
		no	'Great, that was indeed a bad match!'
The triangle and the square are red. ▲■●	focus-weak	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match'
The triangle is red. ▲□ , ▲□○	focus-strong	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match.'
The triangle is red. ▲□ , ▲□○	focus-weak	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match.'
The triangle is red. △■	focus-strong	yes	'Wait, that was actually a bad match!'
		yes	'Wait, that was actually a bad match.'
The triangle is red. △■	focus-weak	yes	'Wait, that was actually a bad match!'
		no	'Great, that was indeed a bad match.'
The triangle and the square are red. ▲■○	focus-strong	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match.'
The triangle and the square are red. ▲■○	focus-weak	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match.'
The triangle and the square are red. △■●	focus-strong	yes	'Wait, that was actually a bad match.'
		no	'Great, that was indeed a good match!'
The triangle and the square are red. △■●	focus-weak	yes	'Wait, that was actually a bad match.'
		no	'Great, that was indeed a good match!'

Table 11: Feedback for focus primes according to priming groups

sentence-picture(s)	group	response	feedback
The triangle or the square is red. ▲ ■	disjunction-strong	yes	'Wait, that was actually a bad match!'
		no	'Great, that was indeed a bad match'
The triangle or the square is red. ▲ ■	disjunction-weak	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match'
The triangle or the square is red. ▲ □	disjunction-strong	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match'
The triangle or the square is red. ▲ □	disjunction-weak	yes	'Great, that was indeed a good match!'
		no	'Wait, that was actually a good match'
The triangle or the square is red. △ □	disjunction-strong	yes	'Wait, that was actually a bad match!'
		no	'Great, that was indeed a bad match'
The triangle or the square is red. △ □	disjunction-weak	yes	'Wait, that was actually a bad match!'
		no	'Great, that was indeed a bad match'

Table 12: Feedback for disjunction primes according to priming groups
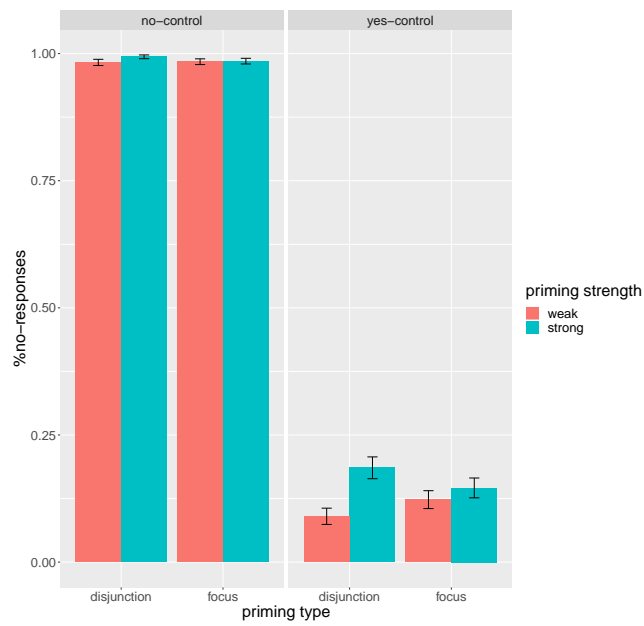
Figure 6: Rate of no-responses to control sentences in the probe phase by priming group. Error bars indicate the standard error.

References

Bott, L., T. M. Bailey, and D. Grodner (2012). Distinguishing speed from accuracy in scalar implicatures. *Journal of Memory and Language 66*(1), 123–142.

Bott, L. and E. Chemla (2016). Shared and distinct mechanisms in deriving linguistic enrichment. *Journal of Memory and Language 91*, 117–140.

Bott, L. and I. A. Noveck (2004). Some utterances are underinformative: The onset and time course of scalar inferences. *Journal of memory and language 51*(3), 437–457.

Breheny, R., H. J. Ferguson, and N. Katsos (2013). Taking the epistemic step: Toward a model of on-line access to conversational implicatures. *Cognition 126*(3), 423–440.

Breheny, R., N. Katsos, and J. Williams (2006). Are generalised scalar implicatures generated by default? an on-line investigation into the role of context in generating pragmatic inferences. *Cognition 100*(3), 434–463.

Chemla, E. and L. Bott (2014). Processing inferences at the semantics/pragmatics frontier: Disjunctions and free choice. *Cognition 130*(3), 380–396.

Chierchia, G. (2013). *Logic in grammar: Polarity, free choice, and intervention*. OUP Oxford.

Chierchia, G., D. Fox, and B. Spector (2012). The grammatical view of scalar implicatures and the relationship between semantics and pragmatics. In P. Portner, C. Maienborn, and K. von Heusinger (Eds.), *Semantics: An International Handbook of Natural Language Meaning*. Berlin: Mouton de Gruyter.

Degen, J. and M. K. Tanenhaus (2015). Processing scalar implicature: A constraint-based approach. *Cognitive science 39*(4), 667–710.

Fox, D. (2007). Free choice disjunction and the theory of scalar implicature. In U. Sauerland and P. Stateva (Eds.), *Presupposition and Implicature in Compositional Semantics*, pp. 71–120. Pelgrave McMillan.

Fox, D. and R. Katzir (2011). On the characterization of alternatives. *Natural Language Semantics 19*, 87–107.

Franke, M. (2011). Quantity implicatures, exhaustive interpretation, and rational conversation. *Semantics and Pragmatics 4*, 1–1.

Geurts, B. (2010). *Quantity Implicatures*. Cambridge University Press.

Gotzner, N., D. Barner, and S. Crain (2020, 04). Disjunction Triggers Exhaustivity Implicatures in 4- to 5-Year-Olds: Investigating the Role of Access to Alternatives. *Journal of Semantics 37*(2), 219–245.

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

Grice, P. (1975). Logic and conversation. In P. Cole and J. Morgan (Eds.), *Syntax and Semantics: Speech Acts*, Volume 3. New York: Academic Press.

Grice, P. (1989). *Studies in the Way of Words*. Cambridge, MA: Harvard University Press.

Grodner, D. J., N. M. Klein, K. M. Carbary, and M. K. Tanenhaus (2010). "some," and possibly all, scalar inferences are not delayed: Evidence for immediate pragmatic enrichment. *Cognition 116*(1), 42–55.

Groenendijk, J. and M. Stokhof (1984). *Studies in the Semantics of Questions and the Pragmatics of Answers*. Ph. D. thesis, University of Amsterdam.

Horn, L. (1972). *On the semantic properties of the logical operators in English*. Ph. D. thesis, UCLA.

Huang, Y. T. and J. Snedeker (2009). Online interpretation of scalar quantifiers: Insight into the semantics–pragmatics interface. *Cognitive psychology 58*(3), 376–415.

Huang, Y. T. and J. Snedeker (2011). Logic and conversation revisited: Evidence for a division between semantic and pragmatic content in real-time language comprehension. *Language and Cognitive Processes 26*(8), 1161–1172.

Katzir, R. (2007). Structurally-defined alternatives. *Linguistics and Philosophy 30*, 669–690.

Levinson, S. C. (2000). *Presumptive meanings: The theory of generalized conversational implicature*. MIT press.

Magri, G. (2009). A theory of individual-level predicates based on blind mandatory scalar implicatures. *Natural language semantics 17*(3), 245–297.

Mascarenhas, S. (2014). *Formal Semantics and the Psychology of Reasoning: Building new bridges and investigating interactions*. Ph. D. thesis, New York University.

Noveck, I. A. and A. Posada (2003). Characterizing the time course of an implicature: An evoked potentials study. *Brain and language 85*(2), 203–210.

Politzer-Ahles, S. and L. Gwilliams (2015). Involvement of prefrontal cortex in scalar implicatures: evidence from magnetoencephalography. *Language, cognition and neuroscience 30*(7), 853–866.

Rees, A. and L. Bott (2018). The role of alternative salience in the derivation of scalar implicatures. *Cognition 176*, 1–14.

Rooth, M. (1992). A theory of focus interpretation. *Natural language semantics 1*(1), 75–116.

Sauerland, U. (2004). Scalar implicatures in complex sentences. *Linguistics and Philosophy 27*, 367–391.

Schulz, K. and R. Van Rooij (2006). Pragmatic meaning and non-monotonic reasoning: The case of exhaustive interpretation. *Linguistics and philosophy 29*(2), 205–250.

Spector, B. (2007). Scalar implicatures: exhaustivity and Gricean reasoning. In M. Aloni, P. Dekker, and A. Butler (Eds.), *Questions in Dynamic Semantics*. Elsevier.

Spector, B. (2016). Comparing exhaustivity operators. *Semantics & Pragmatics 9*(11), 1–33.

Tomlinson Jr, J. M., T. M. Bailey, and L. Bott (2013). Possibly all of that and then some: Scalar implicatures are understood in two steps. *Journal of memory and language 69*(1), 18–35.

Van Rooij, R. and K. Schulz (2004). Exhaustive interpretation of complex sentences. *Journal of logic, language and information 13*(4), 491–519.

Van Tiel, B. and W. Schaeken (2017). Processing conversational implicatures: alternatives and counterfactual reasoning. *Cognitive science 41*, 1119–1154.

Waldon, B. and J. Degen (2020). Symmetric alternatives and semantic uncertainty modulate scalar inference. In *Proceedings of CogSci*.