Pragmatic priming and the search for alternatives

Lewis Bott (Bottla@Cardiff.ac.uk)
School of Psychology, Cardiff University
Park Place, CF10 3AT, Cardiff, UK

Emmanuel Chemla (Chemla@ens.fr)
Ecole Normale Supérieure, LSCP
29 rue d'Ulm, Paris, France

Abstract

Meanings of basic expressions can be enriched by considering what the speaker could have said, but chose not to, that is, the *alternatives.* We report three experiments testing whether there is a single enrichment procedure that stretches across diverse linguistic phenomena. Participants were primed to understand either the basic meaning or the enriched meaning of a sentence. We found that the enrichment mechanism could be primed across some expressions but not others, arguing against a universal enrichment mechanism. Our results have implications for understanding the processing of implied meaning and how linguistic phenomenon should be grouped together.

Keywords: Pragmatics; psycholinguistics; alternatives; implications; structural priming.

Interpreting a sentence requires taking into consideration the combination of words that have been uttered, but also words that have not been uttered, that is, the *alternatives.* For instance, if a speaker says, "John has read some of the books", the listener can use the alternatives to derive the meaning that John has read some, *but not all*, of the books. The derivation procedure would be something like (i) accept that John read some (or all) of the books; (ii) identify "John read all the books" as a relevant *alternative*; and (iii) select this alternative to negate. In this paper we consider how the processor derives the alternatives. Our approach is to apply a structural priming technique (e.g., Raffray & Pickering, 2010) to test whether the search for alternatives can be primed across and within different inferences.

Enrichment by negation of alternatives is a large phenomenon. There is always some phrase or item that may generate an alternative, and furthermore, there is an infinite range of potentially relevant alternatives. Consider the example above again. In the right context, "John has read some of the books" could imply that Bill/Helen/Mary etc. have not read some of the books, or that John has read the books but not seen the films, or even that John has not written some of the books. The wide variety of possible alternatives raises a serious processing question, however: How does the processor know which alternatives to negate? There have been several theories in the linguistics literature that provide partial answers to this question. Horn (1972) suggested that certain expressions are grouped together in the lexicon to form *semantic scales*, and the alternatives for a given item are its scale mates. With *some* for example, *some, many*, and *all* form a semantic scale, and the alternatives for *some* would be *many* and *all*. More liberally, Rooth's (1992) work on focus suggests that alternatives can be any item in the same semantic category as the target (type <e,t> etc.). Intermediately, Katzir (2007) has suggested that alternatives are any items that are less than or equally complex than the trigger, or that are particularly salient in the context. In our study we take a slightly different approach, however. Rather than identifying a set of structural principles for defining the alternatives, we ask whether there is a single procedure that enriches the basic meaning in different linguistic contexts. In doing so, we also seek to find evidence that the seemingly diverse linguistic phenomena share a common root in how they are derived.

Table 1 shows the set of phenomena that we used in our experiments. All of them involve a basic meaning that can then be enriched by negating alternatives. The first column refers to the name of the phenomenon (the *expression*), the second to the basic (or weak) meaning, the third to a plausible alternative, and the fourth to the result of enriching the basic meaning with the alternative.

Expression	Semantic	Alternative	Result
Some	some or all	All	some but not all
Number *n*	at least *n*	Number *n+1*	*n* but not *n+1*= exactly *n*
Plural morphology	vacuous	singular morphology	not singular =plural
Ad hoc	There is an A	There is an A and a B	There is an A and not a B.

Table 1. Experimental phenomena. The semantic form of each expression can be enriched using the negation of alternatives.

The table summarizes the following cases:

(i) *some*, which trigger the archetypical scalar implicature and for which there exist arguments for the alternatives to be stored in the lexicon (see Horn, 1984, or Levinson, 2000).

(ii) Numbers, which are claimed by some authors to operate in a similar manner to the *some* cases (e.g., Horn, 1989, van Rooy & Schulz, 2006) but not by others (e.g., Breheny, 2008). According to the former group, when a speaker says, e.g., "Dave has three children", the weak meaning of the expression, "three," is *at least three*, but this meaning can be enriched to negate the alternatives, *(at least)* *four, (at least) five,* etc. to form the exactly three reading.

(iii) plural morphology, which have been contentiously linked to the *some* case, by providing arguments showing that plural morphemes are semantically vacuous, surprisingly, and that the plural reading is obtained via negation of the singular alternatives (e.g., Spector 2007).

(iv) ad hoc implicatures, for which the alternatives are only specifiable given an appropriate context. For example, if a speaker says, "There is an elephant," and the context suggests that it would have been relevant for him to say, "There is an elephant and a lion," the listener is licensed to infer the alternative is not true, suggesting that the speaker meant that there was an elephant but no lion.

In summary, the phenomena are of diverse kinds: the root alternative trigger may be lexical (*some* and numerals), morphological (plurals) or contextual (ad hoc), and the motivation for these claims may be more or less intuitive and debated, as we described above. They are nonetheless similar in a way that is important for our experiments. The enrichments shown in the Results column are *optional*. In each case, the listener must derive the basic meaning, but then has a choice about whether to enrich the statement and interpret the meaning with the negated alternatives.

Our experiments test whether the enriched meanings shown in Table 1 are all computed by a single, universal mechanism, or whether separate, individual procedures are applied in each case. There is good reason to suppose either of these possibilities might be true. First, in favour of a universal mechanism, all of the cases shown in Table 1 are arguably derived using the same negation-of-alternative procedures. Grice's Quantity maxim, for instance, could be invoked to generate reasoning along the lines of, "well, if the speaker had meant [alternative], they would have said so," (see Chierchia, 2004, for a wider range of views) and the linguistic contexts that give rise to the enrichment are similar across phenomena. The most simple processing view would be that if these phenomena can be grouped together linguistically, then they should share similar processing mechanisms. Conversely, there are also arguments for different enrichment procedures for different phenomena. For example, numbers may behave differently to quantifiers (see e.g., Breheny, 2008), and Katzir's (2007) theory distinguishes the alternatives involved in ad hoc implicatures from those involved in the *some* and number cases (as we describe in more detail in Experiment 2). Furthermore, different types of expressions vary in how frequently they are enriched. For example, Zevakhina & Geurts (2011), show that adjectives in scalar implicatures, such as, "John's cake is ok" (implying John's cake is *not delicious*) are less likely to undergo enrichment than quantifiers, such as "Some of John's cakes were eaten" (implying *not all* of John's cakes were eaten). The variation in enrichment could be because different enrichment mechanisms are involved across different cases.

Overview of Experiments

To test between universal and individual enrichment procedures, we used a structural priming paradigm (see, e.g., Pickering & Ferreira, 2008). We reasoned that if there were a universal mechanism, it should be possible to prime the procedure, that is, make it more likely that the enriched meaning would be derived. Priming across different phenomena would provide support for a universal procedure for searching alternatives, but priming restricted to particular expressions would support individual enrichment procedures.

There are many different versions of structural priming but we modeled our experiment on Raffray and Pickering (2010), who tested priming of scopal relations. In their experiments, participants had to match one of two pictures to a sentence. The sentence always involved *every* and *a*, but let the scopal relation free to create an ambiguous sentence, as in *Every child climbed a hill* (which can be interpreted either as there being a single hill that every child climbed, or multiple hills where every child climbed a separate hill). In the *prime* trials, the pictures were consistent with only one reading of the sentence. For example, for the *Every child climbed a tree* sentence, one of the pictures was of a single hill with multiple children climbing it, and the other picture was of something unrelated like cows in a field. In the trial that immediately followed it, the *probe* trial, participants saw a different *every* sentence and a further two pictures. One picture was consistent with wide scope reading and one with the narrow scope reading. Participants chose which interpretation best matched the sentence. Raffray and Pickering hypothesized that wide scope prime trials would prime a wide-scope reading in the probe trials and *vice versa*, which is exactly what they found.

Our experiments were very similar except that we used sentences that involved the constructions shown in Table 1, rather than *every*. Just like the *every* sentences, our sentences were ambiguous because implicatures are optional. We hoped to be able to prime whether participants interpreted the sentence with or without the enriched meaning. If either a universal enrichment or an individual enrichment procedure can be primed, we would expect priming within each of the expressions in Table 1. More interestingly, if there is a universal enrichment process, we should observe priming across the different expressions.

Experiment 1

Participants saw a sentence and had to match the sentence with one of two pictures. All of the sentences referred to the presence of letters in a set, such as "All of the letters are As." In the experimental trials, the sentences invited enrichment, as shown in Table 1. However, because the enrichment was optional, participants could choose to interpret the sentence in its basic form. This meant that the sentences could have either a *weak* meaning (without enrichment) or a *strong* meaning (with enrichment). For a given sentence, three types of pictures were possible: (a) *false pictures*, that made both readings false, (b) *weak pictures*, that made the weak reading true but the strong reading false, and (c) *strong pictures* that made both readings true.

There were two types of prime trials. First, *weak primes*, which displayed a false picture and a weak picture, so that participants would click on the weak picture and access the weak reading. Second, *strong primes*, which displayed a weak picture and a strong picture. We reasoned that participants would access the strong reading (the one that makes the two pictures different in a relevant way) and click on the strong picture. An example of the weak *some* prime is shown in the upper-panel of Figure 1.

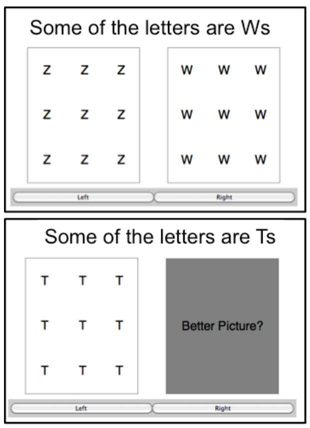

Figure 1. Weak *some* prime (upper-panel), and *some* probe (lower-panel).

In the probe trials, participants read another experimental sentence and saw two more pictures. One of the pictures was a weak picture, and the other picture was a box with “Better Picture?” written inside it. Participants were instructed that the “Better Picture” option should be selected if they did not feel that the other picture sufficiently captured the sentence meaning. The lower panel of Figure 1 shows the probe trials. We expected that participants should click on the weak picture if they accessed the weak reading, and opt for the “Better Picture” option if they accessed the strong reading. Probe trials immediately followed prime trials. Consequently, priming of the enriched meaning would be observed when a participant selected the weak interpretation option more often after the weak prime than after the strong prime (and vice versa).

In Experiment 1 we used the first three expressions shown in Table 1: (1) *some* sentences, for which the weak interpretation picture was a box in which pictures were all one type of letter, namely As, and the strong interpretation picture involved a set filled partly with A’s and partly with B’s. (2) Number sentences, such as “Three of the letters are As,” where the target enriched meaning was *no more than* 3. The weak picture was a box in which 6 letters were A’s, and the strong picture was a box in which exactly 3 of the letters were A’s. (3) Plural sentences, such as, “There are As,” in which the target enriched meaning was *there is more than one A*. The weak picture involved a single A, whereas the strong picture involved multiple A’s.

If (a) all three expressions are related, (b) involve alternatives, and (c) there is a universal enrichment procedure, then priming should be observed within and between the three expressions. If the enrichment mechanism depends on specific structures, priming should be observed only within each expression. We tested within-expression priming by presenting sequences of trials in which the prime from one phenomenon was followed by a probe from the same phenomenon. For example, a *some* prime, such as “Some of the letters are As” would be followed by a *some* probe, such as “Some of the letters are Bs”. We tested between-expression priming by presenting the prime from one expression followed by the probe from a different expression. For example a plural prime, such as “There is an A” might be followed by a *some* probe, such as, “Some of the letters are Bs”.

Method

Participants. In each experiment reported in this paper, we used 50 participants, all recruited online using Amazon Turk and all claiming to be native speakers of English. A different set of participants was used for each experiment. They were paid for their participation.

Design and materials. All trials were either probe trials, prime trials, or bias trials. An experimental sequence of trials was two prime trials followed by one probe trial, i.e., prime-prime-probe. We thought the effect of the prime would be greater if the prime trial was doubled. The prime and probe trials were completely crossed so that each participant saw prime-probe sequences of all possible combinations, e.g., some (weak)-number; number (strong)-some; some (weak)–plural. This meant that for each expression, there were 6 possible sequences (2 within-expression trials, and 4 between-expression trials), and hence 18 sequences in total. We replicated this set 4 times and so there were 72 probe trials and 144 prime trials.

We also added bias trials to encourage participants to (a) select the “better picture” box, and (b) consider appropriate alternatives to the experimental sentences. For example, we included *all* trials so that participants would realise the speaker sometimes said *all* instead of *some.* There were 12 bias trials per set, and 48 in total.

Sentences were all statements about letters, as shown in Figure 1. The particular letters were randomly chosen for each experimental sequence. Each experimental sequence was presented in a random order.

In the prime trials the expected answer (weak or strong) was on the right for half the trials. In the probe trials, the “better picture” box was always on the right.

Results and Discussion

Figure 2 shows the proportion strong interpretations during probe trials. The within-expression effect is shown on the left, and the between-expression effect is shown in the right. A large within-expression priming effect can be seen by the difference between the weak and strong primes, such that there were more strong interpretations after the strong primes than after the weak primes, $F(1,46) = 63.25$, $p < .001$. There was no significant difference in the size of the effect across expressions, however, $F < 1$. More interesting was the priming effect between expressions. The between-priming effect was marginally significant using an ANOVA with probe type and interpretation (weak vs strong), $F(1,50) = 3.063$, $p = .086$, and fully significant using a nonparametric bootstrapping test, $p < .05$ (we also replicate a similar between-expression priming effect in Experiments 2 and 3).

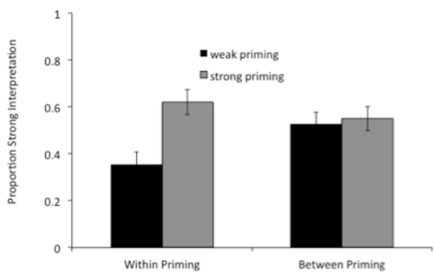

Figure 2. Experiment 1 results.

Our findings suggest that for these sorts of linguistic expressions, there is a universal mechanism that enriches the basic meaning. If the mechanism were tied to individual phenomena, we would not have observed between-expression priming. In Experiment 2, we consider the enrichment mechanism in more detail.

Experiment 2

The enrichment mechanism involves two procedures: (1) identifying the appropriate alternatives, and (2) negating them. The results of Experiment 1 are consistent with either (or both) of these: we could have primed the search for alternatives, or the procedure that negates them. To investigate this in more detail we tested the ad hoc expressions shown in Table 1. The ad hoc expressions are similar to those used in Experiment 1 in that they involve negation of alternatives (see Hirschberg, 1991). However, they are different in that the alternatives for the ad hoc expressions must be determined with reference to the context, whereas the alternatives for the other expressions can be determined lexically (they are context-free). It follows that if we were to observe priming within the ad hoc expressions, but not between the ad hoc expressions and the lexical expressions, we could conclude that the effects of Experiment 1 were at least partly due to priming of the search for alternatives and not priming of the negation process. We would also conclude that there were separate processes computing the alternatives for the ad hoc expressions compared to the lexical expressions. Of course, if we found priming across all of the expressions, as we did in Experiment 1, we could only draw conclusions about the general enrichment process, not the negation of the alternatives.

In Experiment 2, we introduced *ad hoc* sentences into the priming design from Experiment 1. The *ad hoc* sentences were sentences like *There is an A*, which, given the visual context, invited enrichments like *There is an A but not a B*. The weak *ad hoc* prime and an *ad hoc* probe are shown in Figure 3. The design was exactly the same as Experiment 1 except that we replaced the plural expressions with the *ad hoc* expressions, which meant that we had *some*, number, and *ad hoc* expressions.

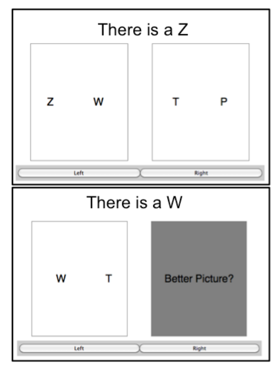

Figure 3. Weak ad hoc prime (upper-panel), and ad hoc probe (lower panel).

Results and Discussion

Proportions of strong responses to the probe are shown in Figure 4. The upper panel shows within-expression priming. For each expression, there were more strong interpretations after the strong prime than after the weak prime, all t's(49) > 4.11, p's < .001, but there was a marginal interaction between probe expression and interpretation, $p = .087$, suggesting less within-expression priming in the ad hoc expressions. The lower-panel shows between-expressions priming. Here, there was robust priming between *some* and number expressions, $F(1,47) = 5.58$, $p = .022$, but not between *some* and *ad hoc* expressions, $F < 1$, or number and *ad hoc* sentences, $F < 1$. There was also an interaction between the degree of between-expression priming for *ad hoc* expressions and the other combinations, $F(2, 98) = 4.42$, $p = .015$.

We did not observe between-expression priming for the *ad hoc* expressions in Experiment 2. However, the within-expression priming effect was marginally smaller for the ad hoc expressions than for the others, and there were far fewer strong interpretation responses. Participants might therefore have had more difficulty identifying the alternatives for the *ad hoc* sentences and consequently, even if between-expression priming was occurring, priming effects would have been smaller and more difficult to observe.

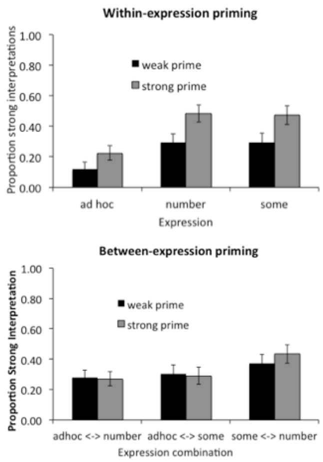

Figure 4. Experiment 2 results. The figure shows responses for each probe expression for within-expression priming (upper panel) and each combination of between-expression priming (lower panel).

Experiment 3

In Experiment 3 we hoped to remedy the low rate of strong interpretations in the ad hoc condition by introducing additional items to increase the salience of the alternatives. We reasoned that participants were always selecting the weak interpretation because they were unsure what might make a "better picture" (i.e., whether the alternative would have any relevance). We therefore introduced 20 extra bias trials at the start of the experiment of the form, "There is an A," with the target picture being a single letter.

Results and Discussion

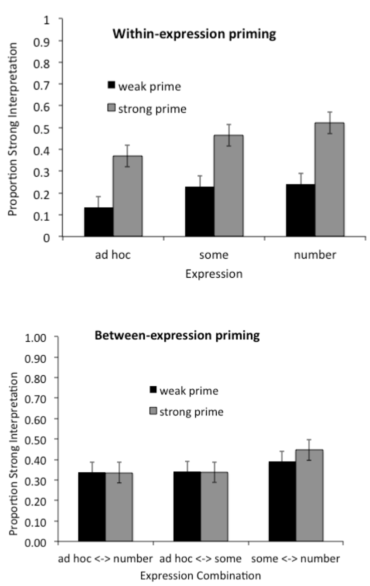

Figure 5. Experiment 3 results.

Within-expression priming is shown in the upper-panel of Figure 5. The proportion of strong interpretations for the ad hoc expressions is much higher than in Experiment 2, and the degree of within-expression priming appears larger. As in Experiment 2, significant within-expression priming is observed in each expression, all $t(49)$'s > 4.76, *p*'s < .001, but we found no evidence that the within-expression priming varied among expressions, F < 1. The lower-panel of Figure 5 shows the between-expression priming trials. As in Experiments 1 and 2, there was robust priming between *some* and number expressions, $t(50) = 2.12$, $p = .036$. Critically however, there was no between-expression priming for combinations involving the ad hoc expressions, *t*'s < 1, and there was a significant interaction between the three combinations, $F(2,100) = 3.39$, $p < .05$.

In this experiment we observed the same sized within-expression priming effect for ad hoc expressions compared to the other expressions. This suggests that the alternatives for ad hoc expressions were just as available too. Yet we failed to observe any between-expression priming effects involving the ad hoc sentences. These findings suggest that between-expression priming was due to priming of the search for alternatives, and not priming of the mechanism that negates the alternatives. Furthermore, our results suggest that there are separate mechanisms for determining context-free alternatives (the lexical expressions) and context-dependent alternatives.

General Discussion

Our studies investigated how the processor enriches basic meanings with negated alternatives. An intuitive and parsimonious processing prediction was that there is a single, universal mechanism across diverse linguistic forms. After all, the enriched meanings that we used could all arguably be derived using the same reasoning. Contrary to this prediction, however, we found that whilst enriched readings of *some,* number, and plural morphology expressions can prime each other, they cannot prime enriched readings of *ad hoc* expressions, even though all the expressions can prime enriched meanings of their own form. This suggests that there are multiple procedures for enrichment based on alternatives, and that these are split between context-free and context-dependent expressions.

We conceive of context-free enrichment procedures as an instruction to the processor to search a part of the lexicon for the appropriate alternatives. For example, with *some*, the instruction would be to retrieve appropriate alternatives, such as *all,* which could then be negated. The context-dependent procedure is different in that it does not involve instructions to search the lexicon, but to search out plausible alternatives from the context. While there might be some overlap between these procedures, the failure to observe priming between the different expressions also provides a robust test that distinguish them.

What is being primed?

We explain our results by referring to the priming of the search for alternatives. Here we consider other explanations.

One that we can eliminate is that we have primed a general acceptance of weak statements. Our items are constructed in such a way that there were informationally weak interpretations (e.g., *some and possibly all*) and informationally strong interpretations (e.g., *some but not all*), and a possible explanation of Experiment 1, therefore, is that participants were primed to accept the weaker/stronger interpretation (and also a potential explanation for Raffray & Pickering, 2010). Experiments 2 and 3 rule out this explanation, however, because the *ad hoc* sentences also had the weak/strong distinction but were not primed by the other expressions. More generally, the failure to observe between-expression priming effects with the ad hoc sentences eliminates any explanation that would apply across all of the expressions.

Another possibility is that our findings could be explained by the priming of alternatives, rather than priming of the search for alternatives. Our within-expression priming effects could indeed be explained in this way. For example, the strong primes of *some* could make the alternative *all* more salient to the participant, and therefore when presented with the probe, such as “some of the letters are As,” the participant might have been more likely to realise that the sentence could have read, “all of the letters are As.” This would then have led them to choose the “better option” box more often. This cannot be the whole story, however, because we also observed between-expression priming. Here, the alternatives were different across expressions and so the salience of alternatives from one expression should not influence the rate of strong responding from other expressions. For example, a *some* strong prime might make *all* more salient, but the salience of *all* should not influence the salience of the *exactly N* reading of the numbers. The between-expression effect cannot be explained by priming of alternatives; it requires priming of the search for the alternatives more abstractly.

Similarities and differences between phenomena

Our results show that *some*, the numbers, and plural morphology can be grouped together, but that *ad hoc* expressions behave differently. This pattern can be related to the linguistic literature that investigates how these particular phenomena are derived.

First, consider the similarity between *some*, the numbers and plurals. These phenomena are very diverse. For instance, some theorists have argued that the numbers and *some* should be considered different phenomena (e.g. Breheny, 2008). Our results provide evidence against an extreme form of this view (that the numbers and *some* are completely unrelated) or the idea that numbers would not involve alternatives. Furthermore, the claim that plurals may be related to the others is an audacious one, which relies on the fully counterintuitive hypothesis that plural morphology is semantically vacuous. Our results provide further striking evidence in favor of this counterintuitive view of plural morphology.

Second, our results also distinguish different phenomena in a meaningful way. Katzir (2007) provides the most precise and complete implementation of alternative generation. In essence, Katzir argues that there are two separate procedures for calculating alternatives. The first involves replacing a phrase by a simpler, related phrase, e.g., *some* => *all*, or *ate a lot*=>*ate*, and the second involves replacing a phrase by a contextually salient phrase which may or may not be simpler (*A* => *A and B*). Interestingly, Katzir specifies different procedures for the computation of *ad hoc* alternatives and alternatives related to the other three phenomena. This is exactly how our results split the landscape as well (see also Fox 2012 for converging developmental data). Hence, we obtain both a confirmation of the theory, and a natural interpretation of our results.

Conclusion

We set out to investigate whether there are abstract procedures for enriching basic meanings considering words that were *not* pronounced, much like the structural priming research has investigated whether there are abstract representations of syntactic structure. Our results show that the scope of the enrichment procedure is wide (e.g., affecting the interpretation of numbers as well as of the plural morphology), and confirm finer-grained properties of the system by distinguishing contextual and non-contexutal alternatives.

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