Diagnosing the presuppositional properties of scalar implicatures[1]

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Abstract. Existing accounts of scalar implicatures (SIs) treat them as post-semantics inferences (Grice, 1975) or as part of the asserted meaning (Chierchia et al., 2009), but these views have recently been challenged based on evidence that in certain environments, SIs behave like presuppositions (Bassi et al., 2021). In this paper, we provide additional evidence for the presuppositional approach by showing that SIs are sensitive to constraints on presupposition accommodation (Heim, 2015; Doron and Wehbe, 2022). In addition, we show that even when the implicature trigger is embedded in a downward-entailing environment and the implicature does not strengthen the overall meaning, we can detect the contribution of a presuppositional implicature. We take this to provide evidence against both the Gricean perspective and the assertive *exh* perspective.

Keywords: Presupposition, Implicature, Global accommodation, Embedded implicatures.

1. Introduction

1.1. Three views on scalar implicatures

The use of words like *or* and *some* in unembedded sentences gives rise to a *not-and* and *not-all* inferences, respectively (1)-(2). It is generally accepted at least since Grice (1975) that these inferences do not directly stem from the core meanings of the words that trigger them, but from some sort of scalar competition with alternative sentences. These inferences are therefore termed *Scalar Implicatures (SIs)*. The nature of the mechanism responsible for SIs is the topic of a long-standing open debate in the semantic literature.

(1) Jane read War and Peace or Anna Karenina.
   a. **Core meaning:** Jane read at least one of War and Peace and Anna Karenina.
   b. **SI:** Jane didn't read both War and Peace and Anna Karenina.

(2) Jane did some of the homework.
   a. **Core meaning:** Jane did at least some of the homework.
   b. **SI:** Jane didn't do all of the homework.

One central fact regarding SIs, and a main reason to suspect that they are not lexically encoded in the meaning of the corresponding lexical items, is that they tend to disappear in downward-entailing (DE) environments. In the paper, we take the scope of negation and the restrictor of a universal quantifier as representative cases of such environments. Notice that *or* and *some* are interpreted in (3)-(4) below with an *at least* meaning, without any noticeable effect of the inferences they give rise to in unembedded sentences.[3] The way in which

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[3]*Some* tends to resist being in the scope of negation, for reasons that are still debated (Baker 1970, Szabolcsi 2004, a.o.). The pattern in DE environments can therefore only be demonstrated in the scope of a universal quantifier in the case of *some*. We take that as an independent fact, and assume that the pattern displayed by *or* reflects the general case.

different theories explain this apparent neutralization of SIs in DE environments will play an important role in our argument here.

(3) a. Jane didn't read War and Peace or Anna Karenina.
b. Every student who read War and Peace or Anna Karenina got an A.

(4) Every student who did some of the homework got an A.

Grice (1975) influentially explained SIs as the result of pragmatic competition between the uttered sentence in examples like (1)-(2) and a stronger alternative. In (1), for example, the fact that the speaker chose not to utter the *and*-alternative presumably allows us to conclude that the speaker believes it to be false. The exact details of the process by which we arrive at this conclusion have been by themselves a topic of debate, giving rise to various families of theories that try to characterize them (e.g. Horn 1972, Gazdar 1979). The differences between them are mostly irrelevant to our purpose here. They all share in common a fundamental claim about the nature of SIs – that they are due to pragmatic, post-semantic reasoning. The neutralization of SIs in DE environments naturally follows in the Gricean framework from the fact that these environments flip the logical relation between propositions, making the alternative utterances less informative.

Chierchia et al. (2012) proposed a different approach to SIs. In their account, SIs are generated by *exh*, an operator at LF. They are therefore not post-semantic, as in the Gricean approach, but arise directly from the semantic composition. A standard (somewhat simplified) definition of *exh* is given in (5). The technical details are again not crucial for our argument here. What is important is that the *exh*-approach analyzes a sentence like (1) as semantically asserting its exclusive inference, as demonstrated in (6).

(5) a. $[\![\text{exh}\ (\phi)]\!] = \lambda w.\ [\![\phi]\!](w) = 1 \wedge \forall q \in \text{IE}([\![\phi]\!], \text{Alt}(\phi))\ [q(w) = 0]$
b. $\text{IE(p, A)} = \bigcap\{A' \subseteq A : A' \text{ is a maximal subset of } A \text{ s.t. } \{p\} \cup \{\neg q : q \in A'\} \text{ is consistent}\}$
(Adapted from Fox 2007)

(6) [exh [Jane read WP or AK]] = Jane read WP or AK, but not both.

Assuming that *exh* can only attach at the matrix level, the *exh*-view explains the lack of an SI in the DE cases like the Gricean view, as a result of the flipped logical relations between the alternatives. But as opposed to the Gricean view, the *exh*-view allows for SIs to be generated in embedded positions. In fact, this is one of the main reasons that motivated the *exh*-view to begin with. This view therefore also has to account for the fact that no embedded scalar implicatures seem to be generated in cases like (3). For example, without any additional assumptions, the *exh*-view wrongly predicts the sentence in (3a) to have the reading in (7), where *exh* takes scope below negation. While attempts have been made to account for the distribution of embedded SIs in a systematic way (e.g. Magri 2009, Fox and Spector 2018), this is still an open issue for the *exh*-view.

(7) [NEG [exh [Jane read WP or AK]]] =
Either Jane read both WP and AK, or she read neither

Recently, Bassi et al. 2021 have proposed a new view of SIs. They adopt from the *exh*-view the idea that SIs are the result of an operator at LF which adds the negation of certain alternatives to the meaning of its prejacent, but their proposal differs from it in an important way:

the operator they propose, termed *pex* (*Presuppositional EXh*), presupposes the negated alternatives, instead of asserting them. The definition is given in (8). Applying it to a basic example like (1), we get a presupposition that Jane did not read both of the books, as shown in (9).

(8) a. $[\![\text{pex}\ (\phi)]\!] = \lambda w. \begin{cases} 1 & \text{iff } [\![\phi]\!](w) = 1 \wedge \forall q \in \text{IE}([\![\phi]\!], \text{Alt}(\phi))\ [q(w) = 0] \\ 0 & \text{iff } [\![\phi]\!](w) = 0 \\ \# & \text{otherwise} \end{cases}$

b. $\text{IE}(\text{p}, \text{A}) = \bigcap\{A' \subseteq A : A' \text{ is a maximal subset of } A \text{ s.t. } \{p\} \cup \{\neg q : q \in A'\} \text{ is consistent}\}$

(Adapted from Bassi et al. 2021)

(9) $[\![\text{pex}\ [\text{Jane read WP or AK}]]\!] = \begin{cases} 1 & \text{iff Jane read WP or AK, and not both} \\ 0 & \text{iff Jane read neither WP nor AK} \\ \# & \text{otherwise} \end{cases}$

One advantage of the *pex*-view over the *exh*-view, pointed out in Bassi et al. 2021, relates to the problem of the distribution of embedded SIs. While the *exh*-account requires an additional mechanism to control the triggering of SIs, on the *pex*-account we can presumably assume that *pex* is inserted at every scope site (namely every t-type node must either be the sister of *pex*, or have *pex* as one of its daughters, as in Magri 2011). To see how this would work, let us consider again the example in (3a).

We assume the LF given in (10), with *pex* occurring both above or below the negation. The global *pex* is idle, like its *exh*-counterpart, since the prejacent has no excludable alternatives. We will thus focus on the embedded *pex*. We have seen in (9) that applying *pex* to *Jane read WP or AK* adds a presupposition that Jane did not read both WP and AK. Assuming that this presupposition projects from under negation, we get the semantics in (10) for the entire sentence. Bassi et al. (2021) argue that this explains the apparent absence of SIs in DE environments – the conditions under which the sentence is true are as if *pex* did not apply at all; the only change made by the embedded *pex* is to switch some worlds from 0 to #.

(10) $[\![\text{pex}\ [\text{NEG}\ [\text{pex}\ [\text{Jane read WP or AK}]]]]\!] = \begin{cases} 1 & \text{iff Jane read neither WP nor AK} \\ 0 & \text{iff Jane read WP or AK, and not both} \\ \# & \text{otherwise} \end{cases}$

To summarize, the three classes of theories of SIs we have presented differ in the pragmatic status they attribute to SIs: they are post-semantic inferences in Gricean theories, part of the semantic assertion in *exh*-theories, and presuppositions in the *pex*-theory. In this paper, we propose a way to tease the theories apart based on this difference. Our proposal, we argue, provides evidence for a presuppositional view along the lines of *pex*.

1.2. SIs as presuppositions

Most of the arguments that Bassi et al. (2021) lay out in favor of the *pex*-theory are based on the way SIs project from different embedded positions. This kind of argumentation is generally complicated by the facts that the distribution of embedded SIs is a debated issue in itself, and that different presupposition triggers are known to project in different ways.

We would therefore like to have a more direct way to probe for the pragmatic status of SIs.

One standard diagnostics for presuppositions which relies on their pragmatic difference from assertions is the *Hey, wait a minute!* test: von Fintel (2004) argues that presuppositions can be objected to with *Hey, wait a minute!* (11b), but entailments that are part of the asserted meaning can't always be objected to in the same way (11a). Bassi et al. (2021) show that scalar implicatures don't behave like presupposition with respect to this test (12). While this does pose a challenge to an analysis of scalar implicatures as presuppositions, it does not definitively rule out a presuppositional account. In particular, as Bassi et al. (2021) argue, presupposition triggers differ with respect to how easy they are to accommodate, and if scalar implicatures are presuppositions that are very easy to accommodate, we wouldn't necessarily expect the *HWAM!* response to be licensed in (12). In order to properly diagnose the pragmatic properties of scalar implicatures, we therefore want a diagnostic that does not rely on a possible resistance to accommodation.

(11) A: The mathematician who proved Goldbach's Conjecture is a woman.
   a. B: # Hey, wait a minute. I had no idea that that was a woman.
   b. B': Hey, wait a minute. I had no idea that someone proved Goldbach's Conjecture. (von Fintel, 2004)

(12) A: Some students passed the exam.
   B: # Hey, Wait a minute, I didn't know that not all of them passed.
   (adapted from Bassi et al. 2021)

In an attempt to address this challenge, Bassi et al.(2021) present the contrast in (13) as evidence for the presuppositional status on SIs. The pattern can be described as follows. Given that we generally believe that tigers are all carnivores, a piece of information which entails that that belief is wrong cannot be conveyed by an SI, as shown by (13a), and neither by a presupposition, as shown by (13d). It can only be conveyed in the assertion, as shown by (13b)-(13c). This means that SIs pattern with presuppositions, and not with assertions.

(13) Today I discovered something interesting...
   a. #Some tigers are carnivorous.
   b. Only some tigers are carnivorous.
   c. Some tigers are herbivorous.
   d. #Only some tigers are herbivorous. (Adapted from Bassi et al. 2021)

More generally, the pattern seems to be that surprising or noteworthy information cannot be conveyed by SIs. This is a well-known property of presuppositions (see Stalnaker 1998, Szabo 2006, von Fintel 2008 for discussion on the topic), which can be further demonstrated by examples like (14) below. Given the contested status of the proposition that B has a sister, it cannot be conveyed by the presupposition, as shown by (14b). The fact that SIs display this property as well is taken by Bassi et al. 2021 as evidence that they are indeed presuppositions.

(14) a. A: Don't lie to me, I know for a fact that you don't have a sister.
   b. B: But I do. In fact, I have to pick her up at the airport.
   c. B': #I have to pick her up at the airport.
   (von Fintel 2008, attributed to Szabo p.c.)

One issue with this argument is that it is based on a constraint we don't fully understand. As noted by Szabo (2006), nothing in our basic model of pragmatics predicts that surprising information cannot be conveyed by a presupposition. It is therefore unclear whether this property can indeed be treated as a defining property of presuppositions. For example, it is unclear how we predict post-semantic inferences to pattern with respect to this property.

Our contribution in this paper is (i) to apply a diagnostic which follows directly from presuppositions' role in the Stalnakerian model of pragmatics and (ii) to investigate a wider range of cases, including implicatures in DE-environments and a variety of triggers. Specifically, our proposed test is based on the assumption that presuppositions must be accommodated before the evaluation of informativity. This allows us to systematically test the predictions of the presuppositional theory of SIs in both global and embedded sentences.

1.3. Structure of the paper

In section 2, we present a diagnostic for presuppositions, explain how it follows from some basic assumptions about the architecture of our pragmatics, and apply it to global SIs. In section 3, we use this diagnostic to test the predictions of the *pex*-theory for SIs triggered in downard-entailing environments. In section 4, we show that certain phenomena that have been attributed to SIs do not pattern with standard SIs with respect to our test, which raises questions about their status. We conclude in section 5.

2. Global SIs

2.1. Post-accommodation informativity with SIs

Our goal in this section is to test whether global scalar implicatures pragmatically behave like presuppositions. We rely on the principle in (15), which is based on lecture notes by Irene Heim and Orin Percus. PAI follows from the Stalnakerian view of presupposition accommodation, where accommodation involves moving to a new common ground with respect to which the utterance is evaluated. Under this view, constraints on assertion, such as informativity, have to be evaluated after accommodation, thus allowing us to tease apart the contribution of the presupposition from the overall truth-conditions. To see how this can be used to distinguish presuppositions from assertions, consider the example in (16). In (16a), after accommodating the presupposition that Jane has 5 kids, the second sentence becomes trivial, thus violating PAI. (16b), on the other hand, is felicitous despite conveying the same information as part of the asserted meaning. Therefore, we can conclude that the information that Jane has five kids is part of the presupposition in (16a) but part of the asserted content in (16b).

(15) **Post-Accommodation Informativity (PAI):** A sentence S_p (presupposing p) can be uttered felicitously only if S_p is informative w.r.t the common ground after accommodating p. (Doron and Wehbe, 2022)

(16) I knew that all of Jane's kids are adopted but today I discovered something interesting...
   a. #All five of Jane's kids are adopted!
   b. Jane has five adopted kids!

In other words, if we model presuppositions in a trivalent framework where the relevant proposition is undefined (#) in worlds where the presupposition is not met, PAI predicts that a sentence is infelicitous as long as there are no worlds in the context set where the sentence is false. This is illustrated in (17) for (16a): since the first sentence in (16a) ensures that (17) is never false in the context, the second sentence in (16a) violates PAI.

(17) $[\![\text{All five of Jane's kids are adopted}]\!] = \begin{cases} 1 \text{ iff Jane has five kids and they are all adopted} \\ 0 \text{ iff Jane has five kids and not all are adopted} \\ \# \text{ otherwise} \end{cases}$

To see how PAI bears on the question of what SIs are, let's compare the predicted truth-conditions of the assertive *exh* theory ((6), repeated below) and the presuppositional theory, where scalar implicatures are presuppositions that are generated by the operator *pex* ((9), repeated below). While the conditions under which the sentence is true are the same under both theories, the falsity conditions are different. We can therefore use PAI to test which theory predicts the correct truth-conditions: in a context where we know that Jane read at least one of the books, (18b) is predicted by PAI to be infelicitous since it is never false, while (18a) is predicted to be felicitous.

(18) Jane read AK or WP.

a. (i) $[\![\textit{exh} \text{ [Jane read AK or WP]}]\!] = \begin{cases} 1 \text{ iff Jane read AK or WP but not both} \\ 0 \text{ iff Jane read neither or both AK and WP} \\ \# \text{ never} \end{cases}$

(ii) **Presupposition:** None

b. (i) $[\![\textit{pex} \text{ [Jane read AK or WP]}]\!] = \begin{cases} 1 \text{ iff Jane read AK or WP but not both} \\ 0 \text{ iff Jane read neither AK or WP} \\ \# \text{ otherwise} \end{cases}$

(ii) **Presupposition:** Jane didn't read all of the books.

Consider the example in (19): (19a) is infelicitous, as predicted by the presuppositional accounts of SIs. The first part of the utterance in (19) makes it common ground that Jane read at least one of AK and WP. (19a) therefore violates PAI in this context, assuming that the *not-and* implicature is a presupposition. We can contrast this with (19b) and (19c), where the *not-and* inference is part of the asserted meaning. To see that the infelicity is not due to an idiosyncratic property of the discourse in (19), (20) provides an example where the relevant contextual information that leads to a PAI violation is not part of the discourse, and we unsurprisingly see that the same infelicity arises.

(19) I knew that Jane read at least one of AK and WP, but today I learned something interesting...

a. # Jane read AK or WP.
b. Jane didn't read both AK and WP.
c. Jane read only one of AK and WP

(20) **Context:** The restaurant H&H has only two courses in the menu – hot dog and hamburger. We know that Jane usually likes to try multiple courses when she goes to a restaurant.

a. # I knew that Jane ate at H&H last night, but today I learned something interesting: she ate the hot dog or the hamburger.
b. I knew that Jane ate at H&H last night, but today I learned something interesting: she ate only one of the courses.

To see that this conclusion generalizes beyond the *not-and* implicature of *or*, consider the analogous examples below with *some*. Here, the presuppositional account predicts a *not-all* presupposition and in contexts where it is common ground that Jane read at least some of the books, PAI predicts the use of *some* to be infelicitous. This prediction is borne out as shown in (22).

(21) a. $[\![\, pex\, [\text{Jane read some of the books}]\,]\!] = \begin{cases} 1 \text{ iff Jane read some but not all of the books} \\ 0 \text{ iff Jane read none of the books} \\ \# \text{ otherwise} \end{cases}$

b. **Presupposition:** Jane didn't read all of the books.

(22) **Context:** AK and WP were two of the assigned books.
I knew that Jane read AK and WP, but today I learned something interesting...
a. # She read some of the assigned books.
b. She didn't read all of the assigned books.
c. She read only some of the assigned books.

We have therefore shown that scalar implicatures do not behave like asserted content with respect to informativity. The data presented here is predicted both if SIs are obligatorily accommodated before informativity is evaluated (as in the presuppositional view), and if it is added to the meaning of the utterance after informativity has been evaluated (as in the post-semantic view). In the next section, we will consider embedded SIs and show that the patterns they give rise to can only be explained in the presuppositional approach. But for now, we take this as an argument against the assertive view of SIs.

2.2. A *Maximize Presupposition* alternative

The *exh*-view might account for the data we presented above by appealing to *Maximize Presupposition!*. To see this, consider *some* as an example in (23). Suppose that (23a) and (23b) compete for the purposes of *MP* (24). Since (23b) is an alternative of (23a) with a stronger presupposition, we expect that (23a) shouldn't be licensed when the presupposition of (23b) is met. Note that our scenarios above ensure that the presupposition in (23b) is met, since they by design make the prejacent of *exh*/*pex* common ground. The *MP* theory therefore predicts infelicity in the same contexts as the *pex* theory does for our cases in section 2.1.

(23) a. $[\![\, exh\, [\text{Jane read some of the books}]\,]\!]$ =
1 iff Jane read some but not all of the books.
Presupposition: none
b. $[\![\text{Jane read only SOME of the books}]\!]$ =
1 iff Jane read some but not all of the books.
Presupposition: Jane read at least some of the books.

(24) **Maximize Presupposition (Heim, 1991)**: If ϕ has a contextually-equivalent alternative ψ which has a stronger presupposition, and ψ's presupposition is satisfied in the context, then ϕ is ruled out.

The predictions of the *Maximize Presupposition* alternative and the PAI account come apart when we consider a version of PAI in which informativity is sensitive to the QUD. In particular, Heim (2015) observes that presuppositions can't settle the QUD. This is exemplified in (25): the presupposition of (25b) (that B has two children) completely settle's A's question and the response is infelicitous. As shown in Doron and Wehbe (2022), this constraint can be conceptualized as a generalized version of PAI given in (26), where the notion of informativity is relativized to the QUD (i.e. where the assertion has to remove at least one cell of the partition that the QUD imposes). When the presupposition settles the QUD, as in (25b), the assertion can no longer be informative, since the resulting partition after presupposition accommodation will have only one cell.

(25) a. A: How many children do you have?
b. B: # I adopted both of my children.
c. B': I have two adopted children. (Doron and Wehbe, 2022)

(26) a. **Post-Accommodation Informativity (PAI):** A sentence S_p (presupposing p) can be uttered felicitously only if S_p is informative w.r.t the QUD and common ground after presupposition accommodation.
b. A proposition p is informative with respect to a QUD Q and a context set C iff p eliminates a cell from the partition corresponding to Q,c (i.e. iff $\exists q \in$ Q: $q \cap C \neq \emptyset \wedge p \cap q = \emptyset$).

We can now test whether scalar implicatures are sensitive to this generlized version of PAI. Consider the examples in (27) and (28): In both cases, the SI settles the asked question (which is presumably the QUD), and the sentences are infelicitous. This is predicted if the scalar implicatures are presuppositions. For example, (27b) would presuppose that Jane didn't solve all of the questions, thus settling the question and leading to a violation of PAI. The *MP* account, on the other hand, is not sensitive to the QUD and therefore cannot explain these additional cases.

(27) **Context:** Jane had to solve 10 questions to complete her homework.
a. Principal: Did Jane complete her homework?
b. Teacher: # No, she solved some of the questions.
c. Teacher: No, she only solved some of the questions.

(28) **Context:** Jane had to solve question 1 and question 2 to complete his homework.
a. Principal: Did Jane complete her homework?
b. Teacher: # No, she solved question 1 or question 2.
c. Teacher: No, she only solved one of the questions.

2.3. Interim conclusion

The examples presented in this section indicate that the pragmatic status of SIs is different from that of assertions, in the sense that SIs cannot contribute to the informativity of an ut-

terance. We argued that that the presuppositional account straightforwardly predicts this, while an assertive-*exh* view doesn't, since it predicts SIs to behave exactly like assertive content. The Gricean view might also be able to account for this data in a different way. On this view, SIs are post-semantic and therefore are plausibly not considered at the stage where the informativity of a sentence is evaluated. Just like the *pex* theory, the Gricean account therefore predicts that SIs can't contribute to the informativity of the utterance. In the next section, we discuss cases where the implicature trigger is embedded and provide additional evidence from PAI against both the Gricean view and the assertive *exh* view.

3. SIs in downward-entailing environments

In this section, we discuss cases where the SI trigger is embedded in a downward-entailing environment, such as in (29a) and (29b). Notice that, absent stress on *or*, the sentences in (29) do not seem to give rise to any implicature. Recall that an assertive *exh* account has to stipulate that *exh* by default can't apply in downward-entailing environments in order to account for these facts. Otherwise, we would expect that there is a parse where *exh* is embedded under negation or in the restrictor of *every*, giving rise to the unattested readings in (30a) and (30b) respectively.

(29) a. Jane didn't read WP or AK.
b. Every student who read WP or AK passed the exam.

(30) a. ⟦ NEG [*exh* [Jane read WP or AK]] ⟧ = Either Jane read both WP and AK, or she read neither.
b. ⟦ Every [*exh* [student who read WP or AK]] [passed the exam] ⟧ = Every student who read WP or AK but not both passed the exam.

As argued in Bassi et al. (2021), the presuppositional account offers a way to avoid this stipulation. In particular, assuming that presuppositions project with a Strong Kleene logic, a presuppositional SI triggered in a DE environment does not change the conditions under which the resulting sentence is true. To see this for negation, consider the predicted truth-conditions in (31). Notice that while the falsity conditions are different from the parse without *pex* in (32), the conditions under which the two sentences are true are identical.

(31) a. $\llbracket \text{not [}pex\text{ [Jane read WP or AK]]} \rrbracket = \begin{cases} 1 \text{ iff Jane read neither WP nor AK} \\ 0 \text{ iff Jane read WP or AK but not both} \\ \# \text{ otherwise} \end{cases}$
b. **Presupposition:** Jane didn't read both WP and AK.

(32) a. $\llbracket \text{not [Jane read WP or AK]} \rrbracket = \begin{cases} 1 \text{ iff Jane read neither WP nor AK} \\ 0 \text{ iff Jane read at least one of WP and AK} \\ \# \text{ never} \end{cases}$
b. **Presupposition:** None

We therefore see that *pex* simply changes the division of labor between presupposition and assertion but does not change the overall truth-conditions when presupposition and assertion are collapsed. This raises an interesting question about whether we can detect this presupposition in cases like (29) with PAI, even when there doesn't appear to be any strengthen-

ing due to the implicature. If we can, then this will provide strong evidence against Gricean and assertive *exh* accounts, both of which predict the complete absence of an implicature in (29).

3.1. Magri effects in downward-entailing environments

Magri (2009) argued that sentences that trigger implicatures give rise to oddness whenever the implicature gives rise to a contextual contradiction. This is illustrated below: in the context in (33), (34) gives rise to an implicature that Jane wasn't assigned both AK and WP which contradicts the context. Magri (2011) shows that this effect interestingly persists when the relevant implicature trigger is embedded in a downward-entailing environment, as in (35a) and (36a). In what follows we show that the *pex* account allows us to predict the infelicity of (35a) and (36a) straightforwardly as a PAI effect, under the assumption that *pex* is obligatorily inserted at all scope sites (Magri, 2011). We then compare the account in terms of PAI to Magri's original account and argue that our account has the advantage of avoiding certain constraints that Magri has to stipulate on *exh* in DE-entailing environment, which lead to potentially undesirable predictions. Moreover, we discuss in the next subsection a further prediction that PAI makes and that Magri doesn't account for.

(33) **Context:** All of the students in the class are assigned one of the following pairs of book to write a report about – either Anna Karenina and War and Peace, or The Catcher in the Rye and A Farewell to Arms.

(34) a. # Jane was assigned AK or WP.
b. Jane was assigned AK and WP.

(35) a. #Jane wasn't assigned AK or WP.
b. Jane wasn't assigned AK and WP.

(36) a. # Every student who was assigned AK or WP got an A on their report.
b. Every student who was assigned AK and WP got an A on their report.

Recall that PAI predicts infelicity for any sentence which denotes a trivalent proposition when there are no worlds in the context set where the sentence is false. Starting with negation, when *pex* is inserted under negation, it gives rise to the trivalent proposition repeated in (37). The context in (33) violates PAI for (37), since it ensures that Jane couldn't have been assigned only one of WP and AK. Therefore, the infelicity of (35a) is predicted under the assumption that *pex* is obligatorily inserted under negation.

(37) $[\![\text{NEG } [\textit{pex } [\text{Jane was assigned WP or AK}]]]\!] =$
$$\begin{cases} 1 \text{ iff Jane was assigned neither WP nor AK} \\ 0 \text{ iff Jane was assigned WP or AK but not both} \\ \# \text{ otherwise} \end{cases}$$

One question that arises here is why we can't prevent the presupposition from triggered by pruning the *and* alternative. We assume, following Bassi et al. (2021), that pruning with *pex* is subject to a relevance constraint, where only irrelevant alternatives can be pruned. Relevance is subject to the following conditions: (i) the prejacent itself has to be relevant

and (ii) relevance is closed under contextual equivalence (following Magri, 2009; 2011 for *exh* and Bassi et al. (2021) for *pex*). This allows us to predict that it is not possible to prune the *and* alternative in our context. In particular, in the context in (33), *Jane was assigned AK or WP* is equivalent to *Jane was assigned AK and WP* and therefore they both have to be relevant.

Turning to the restrictor of *every*, PAI again straightforwardly predicts the infelicity of (36a). The truth-conditions with local *pex* in the restrictor of *every* are given in (38). Again, the context in (33) ensures that (38) is never false: since the common ground ensures that there are no students who read only one of AK and WP, it is trivially true that there are no worlds where some student who read only one of AK and WP didn't get an A. Therefore, assuming again that *pex* is obligatory here, the infelicity in (36a) is predicted.

(38) ⟦ Every [student who [*pex* [was assigned WP or AK]] [got an A on their report] ⟧ =

$$\begin{cases} \text{1 iff Every student who was assigned at least one of WP and AK got an A} \\ \text{0 iff Some student who was assigned only one of AK and WP didn't get an A} \\ \text{\# otherwise} \end{cases}$$

Magri (2011), extending the account in Magri (2009) for matrix cases, argues that these data are predicted if we assume that *exh* is obligatory at every scope site and that the computation of innocent exclusion is blind to contextual information. As discussed above, Magri assumes that *exh* is subject to a relevance condition such that the prejacent of *exh* is necessarily relevant and relevance is closed under contextual equivalence. Therefore, the *and* alternative can't be pruned in (33) and *or* is obligatorily strengthened to *or but not and*, contradicting the context and thus leading to oddness. Similarly, since *exh* is obligatory in downward-entailing environments and the relevance constraint again rules out pruning given the context, Magri predicts that *exh* obligatorily applies and results in the meanings in (39b) and (39c) for negation and the restrictor of *every* respectively. Here, both (39b) and (39c) are trivially true given the context, thus resulting in infelicity.

(39) a. ⟦ *exh* [Jane was assigned WP or AK] ⟧ =
1 iff Jane was assigned WP or AK but not both.

b. ⟦ NEG [*exh* [Jane was assigned WP or AK]] ⟧ =
1 iff Jane was assigned either both WP and AK or neither.

c. ⟦ every student who *exh* [was assigned WP or AK)] got an A on their report ⟧ =
1 iff every student who was assigned WP or AK but not both got an A on their report

Since it is crucial for this account that *exh* is obligatorily inserted even in DE-environments, Magri can't explain the apparent absence of local strengthening in DE-environments by restricting the distribution of *exh*. Instead, Magri argues that there is a general ban on having *exh* lead to weakening. When *exh* is present in DE-environments, we accommodate a QUD where all of the excludable alternatives are irrelevant and can therefore be pruned, thus making the effect of *exh* trivial and avoiding the undesirable weakening effect. This leads to the prediction that if the context forces a QUD where the alternatives are relevant, having the implicature trigger in a DE-envronment should either give rise to weakening or to infelicity (due to violating the ban on weakening).

While it is in general difficult to force a certain QUD and completely prevent accommodation of an alternative QUD, consider the preliminary attempt in (40). A's question in (40b) makes the *and* alternative relevant, and the answer in (40b) makes it clear that B considers the distinction between the students reading one of the two books or both of them relevant, at least for Mary and Jane. In order to accommodate an alternative QUD which prevents weakening, B therefore has to accommodate that for Sue only, the distinction between her reading only one of the books or both of them is not relevant. This seems to us to be a very difficult QUD to accommodate. Given that *Sue didn't read WP or AK* remains felicitous in (40b) and does not give rise to any local strengthening under negation, we take this as preliminary evidence against Magri's proposal.

(40) Context: There are two books the students can read, WP and AK.
   a. A: Which of the two books, if any, did every student read?
   b. B: Mary read only one of WP and AK, Jane read both WP and AK, and **Sue didn't read WP or AK**.

The *pex* account, on the other hand, does not face any problem in (40): *pex* can apply under negation in (40b) and it simply does not strenghten the overall meaning, as shown above. We therefore take this to be an advantage of the account of the Magri infelicity in DE-environments in terms of PAI.

3.2. A further prediction

Looking at the truth-conditions with *pex* in the restrictor of *every* in (38), we can see that Magri's examples are only a special case of the contexts where *pex* predicts infelicity. In particular, PAI predicts that (38) is infelicitous under the conditions in (41), assuming that there is no pruning and that *pex* is obligatory in the restrictor.

(41) **Conditions under which PAI predicts infelicity:**
CG ⇒ Every student who was assigned only one of AK and WP got an A on their report.

To test this prediction, consider the example in (42). Here it is common ground that *everyone who got only one of the blue pill and the red pill survived.* Therefore, PAI predicts that (42b) is infelicitous, since the common ground ensures that it is never false. This prediction seems to be borne out. We therefore see that PAI correctly predicts a further case of infelicity in downward-entailing environments beyond the Magri examples.

(42) **Context:** Mary and Jane are conducting an experiment on rats. They take a group of sick rats and give them either nothing, a blue pill, a red pill, or both. We expect the ones that ate none of the pills to die from their sickness, the ones that ate only one to survive, and we're not sure about the ones that ate both. Looking at data sheet, Mary says: Every rat who got only the blue pill survived and Every rat who got only the red pill survived. Jane responds:
   a. In fact, every rat who got at least one of the blue pill and the red pill survived.
   b. # In fact, every rat who got the blue pill or the red pill survived.

The question of whether pruning can rescue the violation of PAI arises again here. In partic-

ular, unlike in the cases discussed in the last subsection, the *and* alternative is not equivalent to the *or* prejacent in the restrictor of *every*. Therefore, the condition that the alternatives be relevant does not necessarily rule out pruning here. Nevertheless, recall that the variants with and without pruning give rise to the same conditions under which the sentence is true here (and in general in DE-environments). While we leave the details of this for future work, one can formulate a reasonable global constraint on pruning that predicts that pruning is not possible when it does not change the conditions under which the sentence is true.

Note that on an assertive *exh* account, if *exh* is obligatory in the antecedent in (42b) and if we assume that no pruning is possible, then (42b) would be correctly predicted to be infelicitous. This is because the parse with *exh* in the restrictor (43) makes (42b) trivial in the context. The main problem with this approach is that in this context, *exh* leads to weakening of the overall truth-conditions, thus violating Magri's *no weakening* condition. Therefore, we would expect that the alternatives for the local *exh* have to be pruned here in order to prevent weakening but such pruning makes the parse with *exh* no longer trivial. This therefore predicts that (42b) has the same meaning as (42a) and is therefore felicitous in the context.

(43) ⟦Every rate who *exh* [got the blue pill or the red pill] survived⟧ =
1 iff every rat who got only one of the blue pill and the red pill survived.

4. Other SI triggers

In the last two sections, we argued that the *not-and* implicature triggered by *or* and the *not-all* implicature triggered by *some* behave like presuppositions, both in unembedded environments and when the relevant trigger is embedded in a downward-entailing environment. In this section, we apply our diagnostics to free choice and the *exactly* inference of numerals, which have been analyzed as implicatures but nevertheless seem to differ from the other implicatures we looked at in some important ways. We show that these inferences do not behave like presuppositions with respect to our diagnostics, posing a challenge to a uniform account of them as implicatures.

4.1. Free choice

Free choice inferences have been argued to be SIs (Fox, 2007; Bar-Lev and Fox, 2017; Del Pinal et al., 2024). If free choice is in fact an SI which is also due to *pex*, as Del Pinal et al. (2024) argue, we expect that we could similarly detect this presupposition using PAI. Consider an example of a free choice inference in (44). If we attribute this inference and specifically the non-complementary truth-conditions of (44a) and (44b) to a presupposition due to *pex*, then we end up with the trivalent truth-conditions in (45).

(44) a. Jane is allowed to watch TV or play outside is **True iff** *Jane is allowed to watch TV and she is allowed to play outside.*
b. Jane isn't allowed to watch TV or play outside is **True iff** *Jane isn't allowed to watch TV and she isn't allowed to play outside.*
c. **Neither is true iff** *She is allowed to watch TV but not allowed to play outside or vice versa.*

(45) a. ⟦ *pex* [Jane is allowed to watch TV or play outside] ⟧=

$$\begin{cases} \text{1 iff Jane is allowed to watch TV and Jane is allowed to play outside} \\ \text{0 iff Jane is neither allowed to watch TV nor to play outside} \\ \text{\# otherwise} \end{cases}$$

b. **Presupposition:** Jane is allowed to watch TV iff she is allowed to play outside.

Now, PAI predicts that (45) is infelicitous when the common ground has no worlds where (45) is false, for example when we know that Jane is allowed to watch TV. To test this prediction, consider the example in (46a). The fact that (46a) is felicitous, despite the second sentence being trivial after accommodating the presupposition in (45b), shows that free choice does not behave like a presupposition with respect to PAI. Note that this pattern is replicated with the free choice inference of *any*, which has also been argued to be due to an implicature (46b). Finally, free choice, unlike the triggers we discussed in section 3, appears to not be sensitive to PAI in downward-entailing environments (47). This poses a challenge to an implicature account of free choice in general, including those who attribute the PAI effects under negation in section 3 to an obligatory local implicature (i.e. Magri, 2011).

(46) a. I knew that Jane is allowed to play outside tonight, but today I learned something interesting. She is allowed to play outside or watch TV tonight.
b. I knew that Jane is allowed to read War and Peace, but today I learned something interesting. She is allowed to read any book.

(47) a. I knew that Jane isn't allowed to play outside tonight, but today I learned something interesting. She isn't allowed to play outside or watch TV tonight.
b. I knew that Jane isn't allowed to read War and Peace, but today I learned something interesting. She isn't allowed to read any book.

4.2. Numerals

The *exactly* reading of numerals has been argued to be due to a scalar implicatures (Horn, 1972 a.o.). Under such an account, the basic meaning of a sentence like (48) is that Jane read at least 5 books and it is strengthened to an *exactly* reading via the implicature in (48b). Other accounts take the basic meaning of numerals to be the *exactly* reading (e.g. Breheny, 2008) or assume that numerals are ambiguous between an *exactly* and an *at least* reading (e.g. Geurts, 2006). Under the implicature account, if the implicature is due to *pex*, we would derive the trivalent meaning in (49) for (48).

(48) a. Jane read 5 books.
b. **Implicature:** Jane didn't read more than 5 books.

(49) a. ⟦ *pex* [Jane read 5 books] ⟧ =

$$\begin{cases} \text{1 iff Jane read exactly 5 books.} \\ \text{0 iff Jane read less than 5 books.} \\ \text{\# otherwise} \end{cases}$$

b. **Presupposition:** Jane didn't read more than 5 books.

Again, PAI here predicts that (49) is infelicitous in a common ground where it is never false, namely it is common ground that Jane read at least 5 books. This prediction is not borne

out, as shown in (50), thus posing a challenge for an account of numerals as having an implicature due to *pex*.

(50) I knew that Jane read more than 4 books, but today I learned something interesting. She read 5 books.

While we leave a full discussion of the implications of our data to future work, we would like to point out that numerals and free choice have been argued to differ from other scalar implicatures in several other ways. For example, they are processed faster than scalar implicatures, are easier to embed and are acquired earlier in development (Aloni, 2022; Chemla and Singh, 2014a,b; Sauerland et al., 2015; Singh, 2019; Singh et al., 2016). Different ways have been suggested to derive these differences while maintaining that free choice and numerals are in fact implicatures (see Singh, 2025 for a discussion). Our data in this section therefore adds another challenge for a unified account of these inferences as scalar implicatures.

5. Conclusion

In this paper, we have applied the PAI diagnostic to cases of scalar implicatures, in hope of shedding light on their pragmatic status. We have considered three types of theories of scalar implicatures: (i) SIs are post-semantic inferences; (ii) SIs are a part of the asserted content; (iii) SIs are a part of the presupposition. The results of this test seem to support the presuppositional theory: when triggered either globally or locally, SIs behave as if they are accommodated before the informativity of the sentence is evaluated. This is perhaps most striking in the cases of local SIs triggered in DE environments, where the projected SI does not change the conditions under which the sentence is true, but only its falsity conditions. We take our results to support the theory of scalar implicatures in terms of presuppositional exhaustification. We have further shown that two cases which have been treated like SIs do not in fact pattern as expected with respect to our tests, raising questions about there status as scalar SIs. Finally, note that recently, hybrid theories have been proposed in the literature, which rely on a combination of assertive *exh* and pragmatic reasoning (e.g. Cremers et al., 2023). It is unclear to us at this point whether the kind of data we present here can tease these theories apart from the *pex*-theory.

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