An experimental approach to adverbial modification[*,**]

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1 Introduction

Inferences driven by adverbial modification received important attention in various recent approaches of presuppositions as implicatures (e.g., Schlenker 2008, Simons 2001). The goal of this paper is to compare adverbial modification to presupposition and (indirect) scalar implicature. A common feature of these three types of inferences[1] is that they license inferences from negative sentences, as in the illustrative cases below.

(1) Presupposition
   a. John doesn't know that his father is going to receive a congratulation letter.
   Inference: John's father is going to receive a congratulation letter.
   b. In the second term, John didn't start being serious.
   Inference: John was not serious before that.

(2) Scalar implicature
   a. John didn't pass all his exams.
   Inference: John passed some of his exams.
   b. John isn't excellent.
   Inference: John is good.

(3) Adverbial modification
   a. John didn't vote for Paul.
   Inference: John voted.
   b. On Monday, John didn't arrive late.
   Inference: John arrived on Monday.

The present experimental data allow us to compare how these inferences survive in various linguistic environments: negation (section 3.1) and more generally scopes of downward entailing quantifiers as 'none' (section 3.2) and 'less than three' (section 3.3). I will also present a preliminary comparison of the time course of the derivation of these inferences (section 3.4). The

[*] The data presented in this paper come from an experiment which main topic was presupposition. This other aspect of the experiment yielded results which are not discussed here, they lead to a substantially different paper which is currently under revisions: Chemla (2009a).

[**] This work owes a lot to Philippe Schlenker. I am also very grateful to Anne Christophe, Anne-Caroline Fievet and Bart Geurts.

[1] I will only consider the inferential aspect of presuppositions, usually analyzed by means of accommodation.

main conclusion I will draw is that contrary to common wisdom these three types of inference do not belong to fully distinct natural classes, but they are hierarchically ordered: inferences driven by adverbial modification are intermediate between presuppositions and scalar implicatures. This result argues in favor of unified analyses of presuppositions and (scalar) implicatures, and sets the stage for a better understanding of the position of adverbial modification within this landscape.

2 Experimental method

The purpose of this study is to collect naive speakers' compliance to various potential inferences from a given utterance. For this purpose, participants were given a general context (see section 2.1) and ran an explicit inferential task (see section 2.2).

2.1 Context

Participants were asked to imagine the following context: *After an exam session in every topic, 5 or 6 teachers met individually with 10 students of their class (including one named John). These teachers get together to talk about them, informally. These teachers are very well informed about their students, honest, fair...*[2]

The goal was to provide a concrete conversational context in which the participants would do the task. Moreover, the speakers involved in the scenario were presented as "cooperative" speakers so that participants would not resist drawing inferences for irrelevant reasons (e.g., "the speaker is probably wrong" or "the speaker is lying").

2.2 Task

The task was an explicit inferential task as illustrated on Figure 1. Participants were asked to imagine that one of the cooperative speakers involved in the conversation (see section 2.1) utters the first sentence between quotation marks. Their task was to indicate if it is natural, from this sentence, to think that the other sentence at the bottom of the screen is true.

2.3 Two illustrative examples

The examples in (4) and (5) below were offered to the participants before they ran the test. The purpose of the first example in (4) was to show that the participants should not resist "logical" inferences (they were instructed that they would very likely answer *Yes* to such examples). On the contrary, participants were instructed that people may disagree on examples such as (5) and that they should follow their own intuitive judgments.

(4) "John and Mary succeeded in every topic."
suggests that: John succeeded in every topic.

[2]Translated from French.

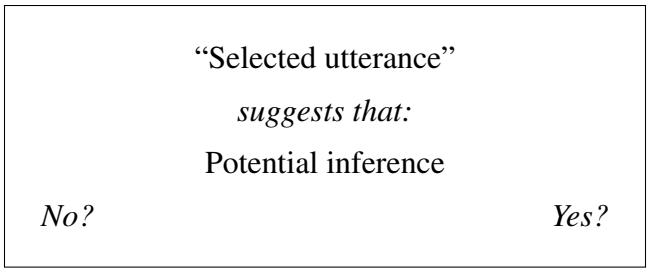


Figure 1: This figure illustrates what participants actually saw on the screen. Participants had to imagine that a cooperative speaker utters the first sentence given between quotation marks (the selected utterance). They were asked to tell whether it would suggest that the second sentence (the potential inference) is true. Participants were taught what was meant by "cooperative speaker" and by the verb "suggest" with instructions and examples.

(5) "Monday, John asked a very good question and insulted a fellow student."
suggests that: John asked a very good question before insulting his fellow student.

2.4 Participants

Thirty native speakers of French aged from 18 to 35 years old were recruited, they were paid a small fee. Participants were mainly university students in the humanities, none of them had any relevant background in linguistics.

2.5 Control results

The material contained 40 non-equivocal examples as (6) and (7) below. Such items can be given a "logical" answer: (6) is valid, (7) is not. Participants responded accordingly 90% of the time. This result guarantees that the participants were paying attention to the task.

(6) "John is French." *suggests that:* John is European.

(7) "John is European." *suggests that:* John is French.

3 Main results

I present here a systematic comparison of the behaviors of scalar implicatures, presuppositions and inferences driven by adverbial modification. In each case, scalar implicatures and presuppositions will differ significantly, while inferences driven by adverbial modification will be intermediate.

3.1 Negation: *I doubt that*

Consider the following test.

(8) Negation test:

a. A given sentence S licenses the inference I.

b. The negation of S licenses the same inference I.

c. In the latter case, the inference is optional (i.e. cancelable).

It is well-known that presuppositions pass this test. This is illustrated in (9). (Notice that the negation is mimicked with the phrase 'I doubt that' in the b-examples, this was the trick used in the experiment to avoid scopal ambiguities.) The inference that it is raining is licensed by (9a) and by its negation (9b). In the latter case, the inference is optional: (9c) shows that the sentence can be consistently followed by the very denial of the inference.[3]

(9) a. John knows that it's raining.
Inference: It is raining.

b. I doubt that John knows that it's raining.
Inference: It is raining.

c. John doesn't know that it's raining, since it is not raining.

Inferences driven by adverbial modification also pass this test:

(10) a. John voted for Paul.
Inference: John voted.

b. I doubt that John voted for Paul.
Inference: John voted.

c. John didn't vote for Paul, since he didn't vote.

In fact, (indirect) scalar implicatures are also predicted to satisfy this paradigm, as the following examples show:

(11) a. John read all the books.
Inference: John read some of the books.

b. I doubt that John read all the books.
Inference: John read some of the books.[4]

c. John didn't read all the books, since he read none of them.

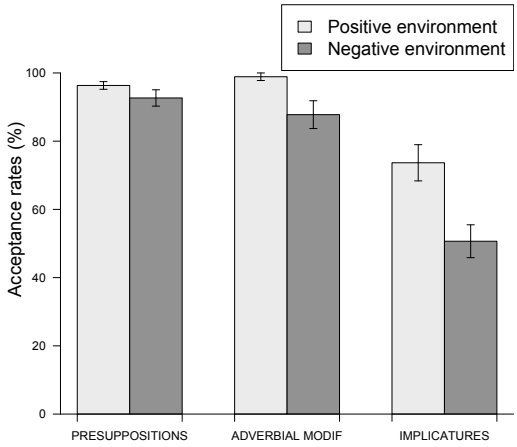
The experiment included items similar to the a) and b) examples in (9) to (11). The acceptance rates of the inferences as well as the relevant statistical results are reported in figure 2. Presuppositions and inferences triggered by adverbial modification are not altered by negation (acceptance rates are identical in positive and negative environments); scalar implicatures are more optional than the other inferences in negative environments. Importantly, the phrase 'I doubt that' differs from regular negation in that it might block a specific stage of the derivation of scalar implicatures: the epistemic step. In short, it is known that scalar implicatures rely on a default "competence assumption" which states that the speaker is well informed about the situation (see Spector

[3]This optionality corresponds to what is usually called *local accommodation.*

[4]The exact prediction of a scalar account is that 'it is not the case that the speaker doubts that John read some of the books', which is very close to John read some of the books.

2003, van Rooij and Schulz 2004, Sauerland 2004). The phrase 'I doubt that' casts doubts on this assumption and this might explain the lower acceptance rate of the inference in these negative environments.

However, let us take the positive case as a baseline to eliminate irrelevant differences between the various types of inferences (e.g., plausibility of the conclusion), we then want to compare the differences between positive and negative cases for each type of inference. This corresponds to the statistical interactions reported in figure 2. We see that this difference is the smallest for presuppositions, the largest for scalar implicatures, and that inferences driven by adverbial modification are intermediate. More precisely, presuppositions and scalar implicatures are significantly different from each other (last line of the table in figure 2), while cases of adverbial modification are intermediate: they do not differ from any of the other two types of inference (if anything, the difference between adverbial modification and presupposition is closer to significance).



Statistics:
3×2 interaction: $F(2, 58) = 3.26, p < .05^*$
2×2 interactions:

	Positive × Negative
Pres. × Adv.	$F(1, 29) = 3.63, \quad p = .067$
Adv. × SI	$F(1, 29) = 1.80, \quad p = .19$
Pres. × SI	$F(1, 29) = 4.60, \quad p < .05^*$

Figure 2: This figure represents the acceptance rates of the inferences of each types when the alleged utterance is positive or negative, see examples (9)a,b, (10)a,b and (11)a,b (and more of the experimental material in appendix: examples (17) to (22)). The resulting statistical interaction is reported globally (3×2 interaction), as well as post-hoc interactions for pairs of phenomena (2×2 interactions given in the table).

3.2 The quantifier 'No'

What happens to these inferences when the relevant linguistic material is bound in the nuclear scope of the quantifier 'No'? Example (12) illustrates this in the case of the presupposition triggered by the verb 'know'.

(12) None of these 10 students knows that his father is going to receive a congratulation letter.

Let us consider two options. These types of sentences may produce an existential inference (as in (13a)) or a universal inference (as in (13b)):

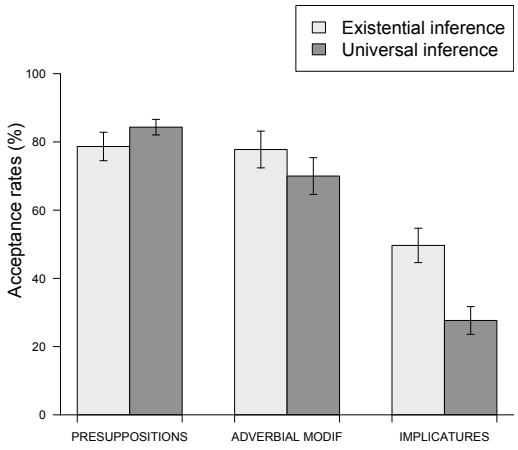
(13) a. Existential (or scalar) inference:
None of these 10 students knows that his father is going to receive a congratulation

letter.
suggests that:
(At least) one of these students' fathers is going to receive a congratulation letter.

b. Universal inference:
None of these 10 students knows that his father is going to receive a congratulation letter.
suggests that:
Each of these students' fathers is going to receive a congratulation letter.

These two options have been considered in the literature about presuppositions (Heim 1983 defends the latter view, while Beaver 1994, 2001 argues for the former view; see chapter 10 in Kadmon 2001 for discussion, and Chemla 2009a for further analyses of experimental data focussed on this question). Interestingly, the existential inference corresponds to what is predicted for the corresponding scalar implicatures cases, as shown in (14). The sentence in (14a) is the counterpart of (12) where the presuppositional part with the verb know has been replaced with a phrase containing the scalar item 'all'. This sentence thus has an alternative spelled out in (14b). This alternative is stronger than the original sentence and usual Gricean mechanisms lead us to the inference that this alternative is false (see (14c)). This is the exact counterpart of the existential presupposition (13b).

(14) a. None of these 10 students read all the books.
b. Alternative: None of these 10 students read any of the books.
c. Predicted inference: (At least) one of them read some of the books.



Statistics:
3×2 interaction: $F(2, 58) = 7.47, p < .05^*$
2×2 interactions:

	Acceptance × Rejection
Pres. × Adv.	$F(1, 29) = 3.37, \quad p = .077$
Adv. × SI	$F(1, 29) = 3.81, \quad p = .061$
Pres. × SI	$F(1, 29) = 16.3, \quad p < .05^*$

Figure 3: This figure represents the acceptance rates of the existential and universal inferences when the relevant inference trigger is bound in the scope of the quantifier 'No'. Relevant examples for presuppositions are given in (13a) and (13b), more experimental material is given in appendix (examples (23) to (28)).

Figure 3 reports the acceptance rates of the universal and existential inferences for presuppositions, scalar implicatures and inferences driven by adverbial modification. As before, pre-

suppositions and scalar implicatures differ significantly, while cases of adverbial modification are intermediate.

3.3 The quantifier 'Less than 3'

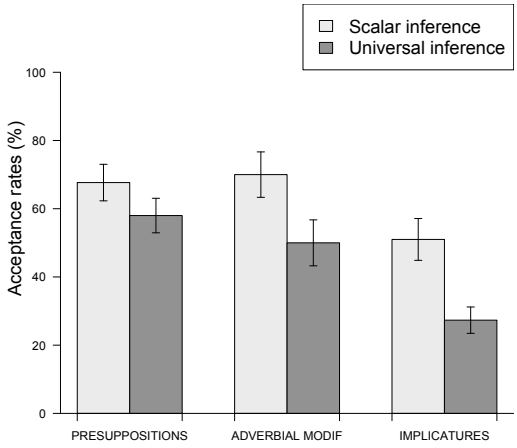
Figure 4 reports the corresponding data with another downward entailing quantifier replacing the quantifier 'No': 'Less than 3' . Sentence (15) is the relevant example in the presuppositional case, and (16) provides the two types of potential inferences.

(15) Less than 3 of these 10 students know that their father is going to receive a congratulation letter.

(16) a. *Scalar inference:*
(At least) three of these students' fathers is going to receive a congratulation letter.

b. *Universal inference:*
Each of these students' fathers is going to receive a congratulation letter.

Once again, presuppositions and scalar implicatures are significantly different, while cases of adverbial modification are intermediate.



Statistics:
3×2 interaction: $F(2, 58) = 5.15, p < .05^*$
2×2 interactions:

	Scalar × Universal
Pres. × Adv.	$F(1, 29) = 2.39, \quad p = .13$
Adv. × SI	$F(1, 29) = .249, \quad p = .62$
Pres. × SI	$F(1, 29) = 5.15, \quad p < .05^*$

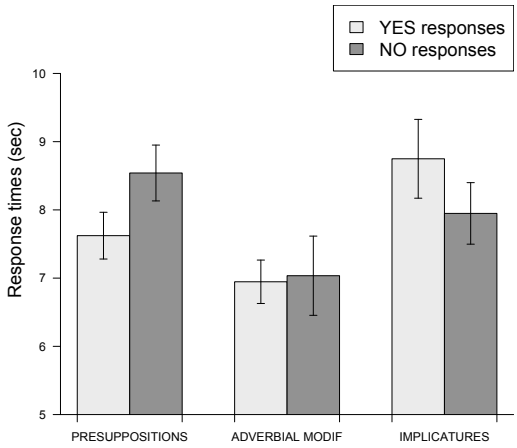
Figure 4: This figure represents the acceptance rates of the scalar and universal inferences when the relevant inference trigger is bound in the scope of the quantifier 'Less than 3'. Relevant examples for presuppositions are given in (15)-(16a) and (15)-(16b), more experimental material is given in appendix (examples (29)-(34)).

3.4 Response times

Finally, figure 5 reports the response times corresponding to the acceptance or the rejection of these inferences. These results correspond to the subset of items for which the inference is as expected: universal inferences for presuppositions and cases of adverbial modification, and scalar inferences for scalar implicatures.

Absolute response times are not informative here because they are influenced by irrelevant factors (e.g., they include reading times which are influenced by the length of the sentences involved, this explains in particular why answers for adverbial modification cases are globally faster: sentences where smaller). So, as before, it is crucial to compare differences. In this case, the difference between the time it takes to accept an inference and the time it takes to reject it gives us an indication of the time needed to compute this inference.

The results for scalar implicatures are in line with the literature (e.g., Bott and Noveck 2004, Breheny et al. 2005): the derivation of scalar implicatures takes time (this result does not reach significance in the present study though: $F(1, 27) = 2.16, p = .15$). Interestingly, presuppositions show the opposite pattern: presuppositions are accepted faster than they are rejected ($F(1, 29) = 21.1, p < .05^*$) and this is significantly different from the pattern of scalar implicatures (the significant interaction is reported in figure 5). More importantly for our present interest, inferences driven by adverbial modification are exactly intermediate between the two other phenomena.



Statistics:

3×2 interaction: $F(2, 53) = 4.11, p < .05^*$

2×2 interactions:

	Acceptance × Rejection
Pres. × Adv.	$F(1, 29) = 1.14, \quad p = .29$
Adv. × SI	$F(1, 29) = 2.02, \quad p = .17$
Pres. × SI	$F(1, 29) = 9.16, \quad p < .05^*$

Figure 5: This figure represents the response times to accept or reject each type of inferences. The difference between acceptance and rejection gives an evaluation of the time needed to derive the inference.

4 Discussion

Presuppositions and scalar implicatures differ systematically in the way they interact with surrounding linguistic material, inferences driven by adverbial modification are exactly intermediate between these two phenomena. These results should provide the empirical basis for a well-grounded analysis of the inferences driven by cases of adverbial modification.

Let me mention two promising directions. First, the adverbial modifications involved in this experiment were systematically sentence final. As such, the modifier might be interpreted in a focus position and this might be the starting point of an explanation for the pattern of inferences observed, see in particular Schwarzschild (1993). Second, Schlenker (2008) suggests that cases

of adverbial modification are "Quasi-Presuppositions": they do trigger standard presuppositions, although the particular syntactic properties of these constructions make them somewhat less robust. Notice that Schlenker's theory of presuppositions rely on Gricean maxims of manner where presuppositions do become a kind of implicature. This approach echoes earlier suggestions from Simons (2001) where the similarity of adverbial modification and presupposition is used to argue for a treatment of both these phenomena as conventional implicatures.

The fact that we found a kind of inference intermediate between presupposition and scalar implicature is telling. Paradoxically, it reduces the distance between the two phenomena and suggests that they have more in common that it is usually thought. For instance, it could be that they originate from the same type of process even if some differences arise later on (see Abusch 2002, 2005 for discussion of how scalar competition could be the source of presuppositional meanings). Similarly, their projection properties may rely on a common mechanism although with little parametric variations (see Chemla 2008, 2009b for a formal proposal along these lines).

Overall, it seems that a close look at inferences driven by adverbial modification leads us to reconsider our usual hermetic categorization of inferences. I also hope that I showed how experimental investigations could be useful to achieve this project and compare other kinds of pragmatic inferences (e.g., focus inferences, free choice inferences) at various levels (e.g., investigate variations between various presupposition triggers, various scalar items).

Appendix: Sample of the experimental material

In this appendix, I provide actual (French) examples used in the experiment. The order of presentation of this material follows the order of the results discussed in the main text.

Negation (see section 3.1)

(17) Presupposition - positive environment

a. Jean sait que son père va être convoqué.
John knows that his father will receive a convocation.

b. Le père de Jean va être convoqué.
John's father will receive a convocation.

(18) Presupposition - negative environment

a. Je doute que Jean sache que son père va être convoqué.
I doubt that John knows that his father will receive a convocation.

b. Le père de Jean va être convoqué.
John knows that his father will receive a convocation.

(19) Adverbial modification - positive environment

a. Lundi, Jean est arrivé en retard.
Monday, John arrived late.

b. Jean est venu (lundi).
John came (on Monday).

(20) Adverbial modification - negative environment

a. Je doute que, lundi, Jean soit arrivé en retard.
I doubt that, Monday, John arrived late.

b. Jean est venu (lundi).
John came (on Monday).

(21) Scalar implicature - positive environment

a. Jean a réussi tous ses examens.
John passed all his exams.

b. Jean a réussi plusieurs de ses examens.
John passed several of his exams.

(22) Scalar implicature - negative environment

a. Je doute que Jean ait réussi tous ses examens.
I doubt that John passed all his exams.

b. Jean a réussi plusieurs de ses examens.
John passed several of his exams.

The quantifier 'No' (see section 3.2)

(23) Presupposition - existential (scalar) inference

a. Aucun de ces 10 étudiants ne sait que son père va être convoqué.
None of these 10 students knows that his father will receive a convocation.

b. Le père d'au moins un de ces 10 étudiants va être convoqué.
The father of at least one of these 10 students will receive a convocation.

(24) Presupposition - universal inference

a. Aucun de ces 10 étudiants ne sait que son père va être convoqué.
None of these 10 students knows that his father will receive a convocation.

b. Le père de chacun de ces 10 étudiants va être convoqué.
The father of each of these 10 students will receive a convocation.

(25) Adverbial modification - existential (scalar) inference

a. Lundi, aucun de ces 10 étudiants n'est arrivé en retard.
Monday, none of these 10 students arrived late.

b. Au moins un de ces 10 étudiants est venu (lundi).
At least one of these 10 students came (on Monday).

(26) Adverbial modification - universal inference

a. Lundi, aucun de ces 10 étudiants n'est arrivé en retard.
Monday, none of these 10 students arrived late.

b. Chacun de ces 10 étudiants est venu (lundi).
Each of these 10 students came (on Monday).

(27) Scalar implicature - existential (scalar) inference

a. Aucun de ces 10 étudiants n'a réussi tous ses examens.
   None of these 10 students passed all his exams.
b. Au moins un de ces 10 étudiants a réussi plusieurs de ses examens.
   At least one of these 10 students passed several of his exams.

(28) Scalar implicature - universal inference

a. Aucun de ces 10 étudiants n'a réussi tous ses examens.
   None of these 10 students passed all his exams.
b. Chacun de ces 10 étudiants a réussi plusieurs de ses examens.
   Each of these 10 students passed several of his exams.

The quantifier 'less than 3' (see section 3.3)

(29) Presupposition - scalar inference

a. Moins de 3 de ces 10 étudiants savent que leur père va être convoqué.
   Less than 3 of these 10 students know that their father will receive a convocation.
b. Les pères de trois (au moins) de ces 10 étudiants vont être convoqués.
   The fathers of three (at least) of these 10 students will receive a convocation.

(30) Presupposition - universal inference

a. Moins de 3 de ces 10 étudiants savent que leur père va être convoqué.
   Less than 3 of these 10 students know that their father will receive a convocation.
b. Le père de chacun de ces 10 étudiants va être convoqué.
   The father of each of these 10 students will receive a convocation.

(31) Adverbial modification - existential (scalar) inference

a. Lundi, moins de 3 de ces 10 étudiants sont arrivés en retard.
   Monday, less than 3 of these 10 students arrived late.
b. Trois (au moins) de ces 10 étudiants sont venus (lundi).
   Three (at least) of these 10 students came (on Monday).

(32) Adverbial modification - universal inference

a. Lundi, moins de 3 de ces 10 étudiants sont arrivés en retard.
   Monday, less than 3 of these 10 students arrived late.
b. Chacun de ces 10 étudiants est venu (lundi).
   Each of these 10 students came (on Monday).

(33) Scalar implicature - scalar inference

a. Moins de 3 de ces 10 étudiants ont réussi tous leurs examens.
   Less than 3 of these 10 students passed all their exams.
b. Trois (au moins) de ces 10 étudiants ont réussi plusieurs de leurs examens.
   Three (at least) of these 10 students passed several of their exams.

(34) Scalar implicature - universal inference

a. Moins de 3 de ces 10 étudiants ont réussi tous leurs examens.
Less than 3 of these 10 students passed all their exams.

b. Chacun de ces 10 étudiants a réussi plusieurs de ses examens.
Each of these 10 students passed several of his exams.

References

Abusch, D. (2002). Lexical alternatives as a source of pragmatic presuppositions. In B. Jackson (Ed.), *Proceedings of SALT XII*. Ithaca, NY: CLC Publications.

Abusch, D. (2005). Triggering from Alternative Sets and Projection of Pragmatic Presuppositions. Ms., Cornell University. Available at http://semanticsarchive.net/Archive/jJkYjM3O/Abusch-Triggering.pdf.

Beaver, D. I. (1994). When variables don't vary enough. In M. Harvey and L. Santelmann (Eds.), *Semantics and Linguistic Theory 4*. Cornell: CLC Publications.

Beaver, D. I. (2001). *Presupposition and assertion in dynamic semantics*. CSLI Publications.

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., N. Katsos, and J. Williams (2005). Are generalised scalar implicatures generated by default? An on-line investigation into the role of context in generating pragmatic inferences. *Cognition 20*, 1–30.

Chemla, E. (2008). Projecting presuppositions with scalar implicatures. In Alte Grønn (Ed.), *Proceedings of SuB 12, Oslo: Department of Literature, Area Studies and European Languages, University of Oslo.*, pp. 81–91.

Chemla, E. (2009a). Presuppositions of quantified sentences: Experimental Data. *Natural Language Semantics in press*.

Chemla, E. (2009b). Similarity: Towards a unified account of scalar implicatures, free choice permission and presupposition projection. Under revision for *Semantics and Pragmatics*.

Heim, I. (1983). On the projection problem for presuppositions. *Proceedings of WCCFL 2*, 114–125.

Kadmon, N. (2001). *Formal Pragmatics: Semantics, Pragmatics, Presupposition, and Focus*. Blackwell Publishers.

van Rooij, R. and K. Schulz (2004). Exhaustive Interpretation of Complex Sentences. *Journal of Logic, Language and Information 13*(4), 491–519.

Sauerland, U. (2004). Embedded Implicatures. *Journal of Cognitive Science 5*(1).

Schlenker, P. (2008). *Be Articulate:* A Pragmatic Theory of Presupposition Projection. *Theoretical Linguistics 34*(3), 157–212.

Schwarzschild, R. (1993). Plurals, presuppositions and the sources of distributivity. *Natural Language Semantics 2*(3), 201–248.

Simons, M. (2001). On the conversational basis of some presuppositions. *Semantics and Linguistic Theory, 11*.

Spector, B. (2003). Scalar implicatures: Exhaustivity and Gricean reasoning. In B. ten Cate (Ed.),

Proceedings of the Eigth ESSLLI Student Session, Vienna, Austria. Revised version in Spector (2007).

Spector, B. (2007). Scalar implicatures: Exhaustivity and Gricean reasoning. In M. Aloni, P. Dekker, and A. Butler (Eds.), *Questions in Dynamic Semantics*, Volume 17 of *Current Research in the Semantics/Pragmatics Interface*. Elsevier.