

Squibs and Discussion

WHEN ARE DOWNWARD-
ENTAILING CONTEXTS
IDENTIFIED? THE CASE OF THE
DOMAIN WIDENER *EVER*

Charles Clifton, Jr.

*University of Massachusetts,
Amherst*

Lyn Frazier

*University of Massachusetts,
Amherst*

1 When Is the Monotonicity of a Context Identified?

It has been known for some time that negative polarity items (NPIs) are often licensed in downward-entailing (DE) contexts—contexts that support inferences from sets to subsets (Ladusaw 1979). For example, the NPI *ever* is licensed in the negative (DE) context (1a) but not in the non-DE context (1b).

- (1) a. Josh didn't ever play chess.
- b. *Josh ever played chess.

We examine sentences in which the NPI is eventually seen to be licensed, but which contain a tempting initial misanalysis under which the NPI does not appear to be licensed. We ask two questions: (a) Are computations about the licensing of an NPI done locally and online, or are they only done in the global context of a full sentence? and (b) If such local computations are made, does a temporary apparent failure of licensing result in lowered acceptability for a globally acceptable sentence?

There is evidence that the DE contexts that support an NPI are used word by word as a sentence is read to guide some aspects of processing. Scalar implicatures (e.g., *some* implicates *some but not all*) are more likely to be reported if the scalar term occurs in a non-DE context than in a DE context (Chierchia 2004, Chierchia, Frazier, and Clifton 2009, Schwarz, Clifton, and Frazier, to appear). Panizza, Chierchia, and Clifton (2009) provide eye-tracking evidence that computation of scalar implicatures (for numerals) is done incrementally,

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immediately when the scalar term is read (which they take to support claims that implicatures are computed locally rather than globally as in Gricean approaches to implicatures; Geurts and Pouscoulous 2009, Grice 1989, Russell 2006).

Event-related potentials (ERPs) have also been used to study the processing of NPIs. Absence of a licenser such as a negative morpheme has been reported to result in the appearance of an N400 (a marker associated with semantic predictability/anomaly) as well as a late positivity (perhaps a P600, often taken as a marker of syntactic processing difficulty) to an NPI, indicating that the licensing is done online. Interestingly, the presence of a licenser in a structurally inappropriate position also reduces the size of the N400, though not as much as a licenser in a structurally appropriate position (e.g., Drenhaus, Saddy, and Frisch 2004, 2005, Drenhaus et al. 2006, Saddy, Drenhaus, and Frisch 2004, Vasishth et al. 2008). Self-paced reading data do not show an immediate effect of spurious licensors, however, suggesting that the ERP effects might be due to semantic associations between words—a factor the N400 is known to be sensitive to (Xiang, Dillon, and Phillips 2009, though further assumptions are needed to address the effect of a spurious licenser on the P600).

2 Incremental versus Delayed Computations: The Case of the Domain-Widening Negative Polarity Item *Ever*

To investigate when the monotonicity (downward-entailingness or upward-entailingness) of a context is identified, we examined the NPI *ever*, which has been analyzed as a domain widener (Chierchia 2006), as illustrated in (2).

- (2) a. Ella didn't go to Paris.
 b. Ella didn't ever go to Paris.

Sentences without *ever* (2a) may be used to make a claim about a particular time period under discussion (e.g., last week), and thus (2a) might be true even if uttered in a situation in which Ella went to Paris at some time in the past. By contrast, *ever* in (2b) serves to widen the domain, and thus (2b) could not be used to make a true assertion if Ella went to Paris at some point in the past. Because *ever* widens the domain, a sentence containing *ever* does not readily tolerate exceptions.

If NPIs such as *ever* are licensed semantically by DE contexts and monotonicity computations come into play only in terms of the global context of the entire utterance, then the nature of the context, DE or non-DE, should be computed with respect to the final syntactic analysis of the sentence. A temporary misanalysis, as occurs in a “garden path” sentence (Bever 1970, Frazier 1987), should not influence the processing of the NPI. In contrast, on a local approach to implicature computation and context determination, one might expect difficulties if an NPI (a domain widener like *ever*) appeared to be unlicensed on the first, erroneous, syntactic analysis of the sentence.

Consider the classic garden path sentence in (3) (Bever 1970).

- (3) The horse raced past the barn fell.

The sentence is initially parsed as a main clause up to the verb *fell*. At *fell*, the initial analysis becomes untenable because *fell* requires a subject and the preceding string has been analyzed as a clause, not a DP. Consequently, on the final, correct analysis, the initial sequence *The horse raced past the barn* must be analyzed as a reduced relative clause.

Strings like *A teacher caught . . .* as in (4) are known to be parsed initially as main clause structures on a par with (3) (Frazier 1987). Affirmative main clauses are non-DE contexts (unless they contain a DE operator). Thus, the local approach would lead one to expect (4b) to be difficult or odd compared to (4a), because the NPI *ever* will at first appear not to be licensed (i.e., before the syntactic garden path is reanalyzed).

- (4) a. A teacher caught with communist literature won't be allowed to teach social studies.
 b. A teacher ever caught with communist literature won't be allowed to teach social studies.
 c. A teacher who was ever caught with communist literature won't be allowed to teach social studies.

If this initial oddity persists in ratings of the final sentence, then reduced relatives containing NPIs will be rated worse than unambiguous relatives like (4c), where it is clear from the outset that the NPI is licensed. An NPI is licensed in a relative clause with a universal head or with a generic interpretation because the structures are DE contexts, as shown by the fact that the truth of (5a) implies the truth of (5b).

- (5) a. Every man/A man who eats vegetables will be healthy.
 b. Every man/A man who eats carrots will be healthy.

Apart from the question of incremental computation of the monotonicity of contexts, it is interesting to know under what circumstances acceptability judgments of sentences presented without time pressure reflect temporary difficulties in processing sentences. Previous findings suggest that ungrammatical sentences with temporary grammatical analyses receive higher acceptability ratings than counterparts without the temporary misanalysis (Fanselow and Frisch 2006), and they show that sentence-processing difficulties can be reflected in the final acceptability ratings of sentences (Sprouse 2008). How temporary syntactic analyses interact with logical properties of context may also be reflected in acceptability judgments.

3 Experimental Findings

Below we report two written acceptability judgment studies undertaken to test whether the initial incorrect (non-DE context) analysis

of reduced relatives results in decreased acceptability when they contain an NPI. Experiment 1 tested sentences with reduced relative clauses (RRCs) like those in (6). Sentences with full relative clause (FRC) structures served as controls.

- (6) a. [RRC, –ever]
 A man arrested in this country won't break the law here again.
- b. [RRC, +ever]
 A man ever arrested in this country won't break the law here again.
- c. [FRC, –ever]
 A man who was arrested in this country won't break the law here again.
- d. [FRC, +ever]
 A man who was ever arrested in this country won't break the law here again.

The prediction that (6b) should be rated as slightly odd because of the temporary problem of *ever* occurring in a non-DE context was tested using 24 sentences like those in (6), plus their counterparts with a plural subject (*Men ever arrested . . .*). There were eight versions of each sentence, generated by the factorial combination of +/–*ever*, full versus reduced relative clause, and singular versus plural subject. Half the versions contained *ever* (indicated as +*ever*); half did not (–*ever*). Half had a head noun followed by an RRC (6a–b); half had a head noun followed by an FRC (6c–d). Half had a singular head noun, as illustrated; half had a plural head noun. The number of the head noun was manipulated to make sure that the oddness of (6b), if confirmed, could not be due to an independent bias against having an indefinite singular in a nonepisodic context. All experimental sentences are available from the authors (cec@psych.umass.edu, lyn@linguist.umass.edu).

The resulting sentences were arbitrarily divided into two subsets of 12 sentences, each of which was divided into eight counterbalanced lists. Four of the lists contained just singular head nouns, and the other four, plural head nouns. Each list contained three sentences in each of the four versions illustrated in (6), and each sentence was tested in each of these versions in one singular and one plural list. Each sentence was followed by a 5-point rating scale, labeled “How acceptable was that sentence?,” with “1” being “unacceptable” and “5” being “fully acceptable.” The sentences were combined with a total of 84 items testing unrelated questions. Each of these sentences was followed by one of a variety of types of questions, including two-choice questions and plausibility rating scales.

Ninety-six University of Massachusetts undergraduates were tested in individual half-hour sessions. They were given instructions, including the instruction that they were to rate some sentences for acceptability, which was explained to them as how much “the sentence sounds like a sentence that a native speaker of English could say or

understand without noticing anything peculiar or ungrammatical or odd or confusing about it.” Six participants were assigned to each of the 16 (2 sets of 8 counterbalanced lists) lists described above. A computer presented 6 practice items, then the 12 experimental items plus the 84 other items, in individually randomized order. A participant saw a sentence on the computer screen and pressed a key on the computer keyboard after reading it. The question and rating scale then appeared, and the participant pressed a number key, corresponding to the chosen acceptability rating.

The mean acceptability ratings appear in table 1. RRC examples were rated worse than FRC examples; +ever examples were rated worse than –ever examples. As predicted, there was an interaction of \pm ever and FRC/RRC, with the lowest ratings being accorded the RRC +ever forms.

The significance of the effects of type of relative clause, presence versus absence of *ever*, subject number, and their interactions was tested using a mixed-model analysis with participants and items as partially crossed random factors, using the default contrast coding of the factors. We chose this analysis over the more familiar ANOVA framework, separately testing for generalization to participants and items, for a variety of reasons detailed by Baayen, Davidson, and Bates (2008). These reasons include the fact that the linear mixed-model analysis permits simultaneous generalization to participants and items and encourages comparisons of various models to identify the most adequate one. The R statistical package (<http://www.R-project.org>) was used for all analyses. Because there is no principled way of calculating the degree of freedom to be used in significance tests of the coefficients of the linear mixed model, precluding the use of standard *t*-tests, the effects were tested using Markov Chain Monte Carlo sampling (again, see Baayen, Davidson, and Bates 2008 for justification). The interaction of the presence of *ever* and the type of relative clause was significant ($t = 2.41$, $pMCMC < .02$). The penalty for having *ever* was 0.68 for sentences with RRCs, and a significantly smaller (and nonsignificant; $t < 1.0$) 0.25 for sentences with FRCs. Sentences with RRCs were rated as less acceptable than ones with FRCs ($t = 5.17$, $pMCMC < .001$, tested for sentences with *ever*, the intercept in the linear mixed model, but also approaching significance for sentences

Table 1

Mean (and standard error) acceptability ratings, Experiment 1
(1 = “unacceptable,” 5 = “fully acceptable”)

Condition	Singular head noun	Plural head noun
[RRC, –ever]	3.87 (0.11)	3.69 (0.11)
[RRC, +ever]	3.17 (0.12)	3.06 (0.12)
[FRC, –ever]	4.01 (0.11)	3.97 (0.11)
[FRC, +ever]	3.61 (0.11)	3.85 (0.10)

without *ever*, $t = 1.91$, $pMCMC < .06$). No effect involving singular versus plural subjects approached significance.

The results of Experiment 1 confirmed the prediction that monotonicity is computed locally, not just with respect to the final correct analysis of a sentence. Even though *ever* was globally licensed by the final analysis of the sentence, the fact that it was apparently unlicensed in the initially favored analysis of the RRC sentences resulted in its presence lowering acceptability ratings in those sentences.

To further test the hypothesis that NPIs in RRC sentences are difficult because the NPI appears to be unlicensed, Experiment 2 tested the sentences from Experiment 1 with negation in the head of the relative, as illustrated in (7).

- (7) a. [RRC, –ever]
 No man arrested in this country will break the law here again.
- b. [RRC, +ever]
 No man ever arrested in this country will break the law here again.
- c. [FRC, –ever]
 No man who was arrested in this country will break the law here again.
- d. [FRC, +ever]
 No man who was ever arrested in this country will break the law here again.

If the difficulty with NPIs in reduced relatives is indeed that the NPI appears not to be in a DE context, then the effect should go away in Experiment 2 since the negation creates a DE context. Consequently, there should be no difficulty with an example like (7a) relative to its (7b) counterpart without *ever*.

The singular sentences from Experiment 1 were altered by substituting *no* for *a* and changing the polarity of the predicate, as appropriate. The plural sentences used in Experiment 1 were not tested in Experiment 2. The four versions of each sentence defined by the factorial combination of +*ever* versus –*ever* and RRC versus FRC were divided into four counterbalanced lists of 24 sentences and combined with 80 sentences from unrelated experiments.

Forty-eight University of Massachusetts undergraduates were tested using a procedure similar to that used for Experiment 1, except that 12 participants were assigned to each of the counterbalanced lists, each participant saw all 24 experimental sentences, and the acceptability rating scale ranged from “1” = “terrible” to “5” = “perfect.”

The mean ratings appear in table 2. A multilevel analysis with participants and items as crossed random terms, and type of relative clause and presence of *ever*, similar to the analysis of Experiment 1, was conducted. No effect approached significance ($t < 1.0$ except for the apparent cost of having *ever* present, where $t = 1.25$, ns). The pattern of results clearly differs from that observed in Experiment 1:

Table 2

Mean (and standard error) acceptability ratings,
Experiment 2 (1 = “terrible,” 5 = “perfect”)

Condition	
[RRC, –ever]	3.59 (0.07)
[RRC, +ever]	3.43 (0.07)
[FRC, –ever]	3.58 (0.06)
[FRC, +ever]	3.49 (0.07)

the interaction observed in that experiment disappeared in Experiment 2. Apparently, the presence of the initial *no* immediately licensed the NPI *ever* in Experiment 2, while *ever* initially appeared to be unlicensed in the RRC versions of Experiment 1.

4 Conclusions

It has been claimed that humans come biologically equipped to acquire and use human languages and, further, that this remarkable ability includes a natural language deductive system (Chierchia 2006). From this perspective, it is not surprising that on an essentially word-by-word basis, the language processor may determine the monotonicity of the current sentence context. Consequently, even temporary syntactic analyses that place an NPI in a non-DE context may give rise to an oddity that persists in final judgments of the acceptability of a sentence. (For other examples of acceptability judgments being influenced by temporary analyses, see Fanselow and Frisch 2006, Sprouse 2008.)

The idea that the processor keeps track of the monotonicity of its current context fits well with the idea that implicature computation may be local, and not just determined by global properties of the utterance. Of course, local monotonicity determination is only a precondition for local computation of implicatures; it does not entail local computation of implicatures.

On the other hand, it is certainly easy to imagine that the world might have been otherwise: logical properties of contexts, whether a context would support an inference from sets to subsets, vice versa, or neither, might have been properties that came into play only when language was used in a logical mode for verification of inferences or the like. We thus take it to be an interesting property of natural language processing that close tabs are kept on the monotonicity of sentence contexts as the analysis of a sentence proceeds.

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A PUZZLE ABOUT P-STRANDING
AND A POSSIBLE SOLUTION

Alex Drummond

University of Maryland

Norbert Hornstein

University of Maryland

Howard Lasnik

University of Maryland

In English, \bar{A} -movement operations that move elements to the left are able to strand prepositions—(1)—but those that move elements to the right—(3b)—cannot, as observed by Ross (1967).

- (1) a. Who₁ did you look at t_1 ?
b. It was Mary₁ that I looked at t_1 .
- (2) a. John saw [the man who lived next door] in the living room yesterday.
b. John saw t_1 in the living room yesterday [the man who lived next door]₁.
- (3) a. John looked at [the man who lived next door] in the living room yesterday.
b. *John looked at t_1 in the living room yesterday [the man who lived next door]₁.
cf. John looked in the living room yesterday at [the man who lived next door].

Why the difference? Bresnan (1976) presented an ingenious account based on the A-over-A Condition (Chomsky 1964). Indicating that ‘Heavy NP Shift’ can apply to PPs as well as to NPs, she formulated the process in terms of [–V], the feature assumed to be shared by N and P. She then observed that the operation of a transformation extracting a heavy NP out of a heavy PP would violate the A-over-A Condition. There is at least one difficulty with this account: rightward movements

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