

An experimental investigation of NPI licensing under DE flip-flop

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This paper presents the results of an experiment testing the acceptability of NPIs in contexts with 0-3 downward entailing operators. The results support a domain-based approach to NPI licensing, such as the one proposed in Homer (2012).

Background Approaches that tie the licensing of NPIs to downward-entailment fall into three groups. First, there are operator-based theories [Op], which simply state that NPIs must be c-commanded by or within the semantic scope of *at least one* downward-entailing [DE] operator (Ladusaw, 1979; von Stechow, 1999). For Op theories, NPIs are licensed for sentences that contain at least one DE operator. Second, there are environment-based theories [Env], which state that NPIs must be in a DE environment. Under the assumption that the default entailment of a sentence is upward-entailing (UE), and assuming that DE operators reverse the polarity of entailment, an odd number of DE operators will yield a DE environment and an even number will yield a UE environment. This phenomenon is sometimes called *flip-flop*. Given this, Env theories predict that NPIs are only licensed in sentences with an odd number of DE operators and not in sentences with an even number. Finally, there are sub-environment-based theories [Sub-Env] like the one proposed by Homer 2012, which state that NPIs must be contained within a syntactic domain that is DE. For many speakers, this domain is the Polarity Phrase [PoP]. The critical prediction of Homer’s (2012) Sub-Env approach is that an NPI can be licensed in a sentence that has an even number of DE operators as long as the NPI is within a syntactic domain that has an odd number of DE operators.

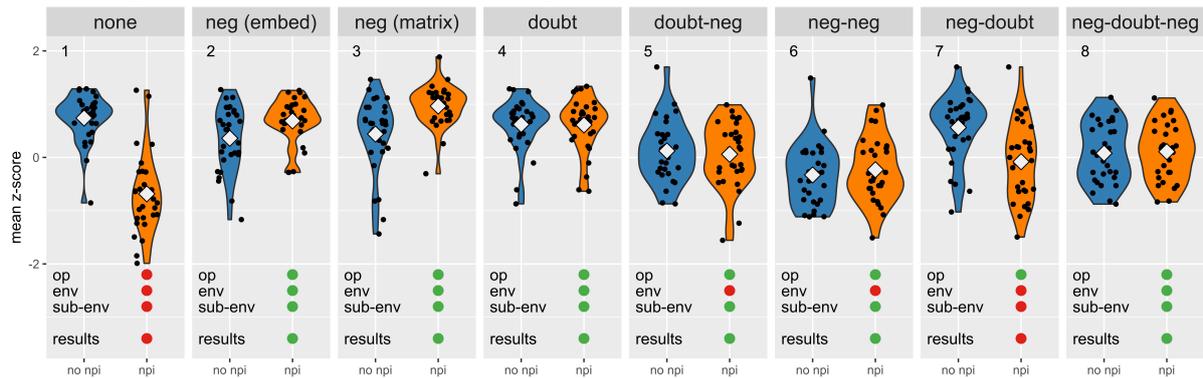
Experiment The goal of our experiment is to test the acceptability of NPI licensing within sentences with multiple DE operators. Though Homer (2012) presents some informally collected judgments in support of his sub-environment theory, the judgments remain relatively controversial. To tease apart the three types of theories (Op, Env, Sub-Env), we constructed 8 sentence schemas that contain different combinations of DE operators. For each combination, we constructed a control condition with no NPI and a target condition with an NPI. Superficially, these 16 sentences form a 2x2x2x2 design (matrix negation x matrix verb x embedded negation x npi). But for the purposes of teasing apart these three theories, we can treat them as 8 pairwise-phenomena, where we define an unlicensed NPI as being significantly less acceptable than the same sentence with no NPI. The table below provides an example of each combination of DE operators with the NPI, organized such that the first four establish the basic NPI facts, and the second four tease apart the three theories. The predictions of each theory are given in the rightmost three columns.

Pair	#DE	Sentence	Op	Env	Sub-Env
1	0	Alex thinks that the student experienced any relief.	x	x	x
2	1	Alex thinks that the student didn’t experience any relief.	✓	✓	✓
3	1	Alex doesn’t think that the student experienced any relief.	✓	✓	✓
4	1	Alex doubts that the student experienced any relief.	✓	✓	✓
5	2	Alex doubts that the student didn’t experience any relief.	✓	x	✓
6	2	Alex doesn’t think that the student didn’t experience any relief.	✓	x	✓
7	2	Alex doesn’t doubt that the student experienced any relief.	✓	x	x
8	3	Alex doesn’t doubt that the student didn’t experience any relief.	✓	✓	✓

Eight unique tokens were created for each of the 16 conditions in lexically matched sets. Importantly, the object noun in the embedded clause was always an abstract mass noun in order to minimize the possibility of interpreting *any* as a free-choice item in UE environments (Parker & Phillips, 2016). The matrix verb was always *think* or *doubt*. The 16 conditions were divided into two experiments, each with 8 target conditions. Each experiment was 31 items long: 9 practice items, one token for each of the 8 target conditions, and 14 fillers. The task was a 7 point (Likert-esque) rating scale. For each experiment, 30 participants were recruited from Amazon Mechanical Turk.

Results We z-score transformed the responses of each participant to eliminate scale bias before analysis. We ran eight one-tailed t-tests with a Bonferroni-corrected p-value of 0.00625 as a criterion for significance. We report the results below using violin plots to reveal variation, with means represented by a white diamond, the predictions of each theory indicated with colored dots (green for licensed, red for unlicensed), and significant differences indicated by the colored dot next

to *results* (green for no difference, red for a significant difference).



Pair 1 demonstrates canonical failure of NPI licensing (no DE operator in the sentence at all). Pairs 2, 3, and 4 demonstrate the licensing of NPIs under sentential negation (embedded and matrix) and *doubt*. All four pairs behaved as predicted by all three theories. The critical pairs were 5-8. Pairs 5 and 6 have two DE operators, one in the matrix clause and one in the embedded clause. These are predicted to license NPIs by the Op and Sub-Env approaches, but not the Env approach, because the entire sentence is UE. Our results reveal no difference between the no-NPI and NPI sentences for these two pairs, suggesting that the NPI is licensed. This eliminates the Env theory from consideration. Pair 7 is the critical pair for distinguishing Op and Sub-Env approaches, as it has two DE operators in the matrix clause: the Sub-Env approach predicts that the NPI should be unlicensed because there is no PoIP (the syntactic domain) that is DE, whereas the Op approach predicts that the NPI should be licensed because there is at least one DE operator scoping-over/c-commanding the NPI. Our results suggest a significant decrease in acceptability for the NPI, suggesting that Sub-Env theories, such as Homer (2012), are more likely to be correct. Pair 8 confirms that adding a third DE operator (in the embedded clause) licenses the NPI, eliminating the difference between conditions.

NPI Illusions Though the pattern of effects that we see in this experiment confirm the Sub-Env predictions, the finer details of the results also help to explain why the informally-collected judgments that Homer (2012) reported have been controversial. The issue is that the size of the effect (i.e., the difference between the no-NPI and NPI conditions) in the unlicensed NPI pair 7 (the critical case) is much smaller than the effect in the unlicensed NPI in pair 1 (the typical case). This smaller effect means that the absolute rating of the unlicensed NPI in pair 7 is much higher than the unlicensed NPI in pair 1. In fact, the unlicensed NPI in pair 7 is roughly equally as acceptable as the licensed NPIs in pairs 6 and 8. Mismatches between absolute acceptability and difference effects have become more and more common in the experimental syntax literature (e.g., Featherston 2005), underscoring the importance of well-chosen control conditions and experimental designs. However, in this case, there appears to be a bit more going on. One hypothesis is that this pattern may be due to the well-known grammatical illusions that arise for NPI licensing (Xiang et al. 2009, Parker & Phillips 2016). The typical NPI illusion occurs when sentential negation linearly precedes, but does not c-command, an NPI. In this case, for sentences containing the sequence *don't doubt*, there is sentential negation c-commanding the NPI; the “illusion” is a weakening of the UE effect of *doubt*. This hypothesis predicts that participants who do not experience an NPI illusion should find the sequence *don't doubt* unacceptable with an NPI due to the UE environment it creates, while participants who do may find the sequence more acceptable due to the presence of potential DE operators. Future processing studies can test this account by investigating the extent to which sentences with NPIs and multiple DE operators display the same patterns as other NPI illusions.

References. Featherston, S. (2005). Magnitude estimation and what it can do for your syntax: some wh-constraints in German. *Lingua* 115(11), 1525-1550. von Stechow, K. (1999). NPI-Licensing, Strawson-Entailment, and Context-Dependency. *Journal of Semantics* 16(2), 97-148. Homer, V. (2012). Domains of polarity items. *Journal of Semantics*, 1-54. Ladusaw, W. A. (1979). *Polarity sensitivity as inherent scope relations*. Doctoral dissertation. Parker, D., & Phillips, C. (2016). Negative polarity illusions and the format of hierarchical encodings in memory. *Cognition* 157, 321-339. Xiang, M., Dillon, B., & Phillips, C. (2009). Illusory licensing effects across dependency types: ERP evidence. *Brain and Language* 108(1), 40-55.