Multiple pressures to explain the 'not all' gap

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Overview Horn (1973) famously observes that languages frequently lexicalize three corners of Aristotle's square of opposition (*all*, *none*, *some*), but rarely lexicalize the concept 'not-all'. This generalization is robust across languages and across domains of quantification: times (*always*, *never*, *sometimes* vs. **not-always*) and worlds (*required*, *forbidden*, *allowed* vs. **not-required*). Horn (1973) explains part of this observation using pragmatic mechanisms: specifically, *some* implicates *not all* (by competition with *all*), and *not all* implicates *some* (by competition with *none*). The two statements are thus contextually equivalent, so natural language does not need to lexicalize all four meanings—three corners of the square suffice.

Why then do languages lexicalize *some* and not *not-all*? Two hypotheses have been proposed. On the MARKEDNESS HYPOTHESIS, monotone decreasing operators are inherently more difficult to process than monotone increasing operators, possibly due to a simpler cognitive representation (Katzir & Singh 2013). On the INFORMATIVITY HYPOTHESIS, the properties denoted by nouns, verbs, and adjectives generally hold of a minority of objects (e.g. more things are not purple than are purple). As a consequence, '*Something is P*' is usually more informative—and thus more useful—than '*Not all things are P*' from a probabilistic perspective (Enguehard & Spector 2021). Note that these hypothesized pressures are not mutually exclusive.

Here, we describe new predictions of these theories, which we test in an experimental setting. First, we present crosslinguistic data that suggests that the pressure to not lexicalize *not-all* is weaker for modal quantification than for individual quantification. We show that this can in principle be explained by the informativity hypothesis (but not the markedness hypothesis) since the relevant probabilistic properties depend on contingent facts about the lexicon and the world.

We then measure these probabilistic properties in an online experiment in which subjects evaluate the surprisingness of quantificational statements. The results provide evidence for a *combination of both pressures*. Overall, the pressure from markedness is stronger than the pressure from informativity, but informativity still plays a role to explain differences between different domains.

Differences between domains? Typologically, there may be evidence that differences exist between the three domains of quantification. While the lexicalization biases can be found in some form for each, the biases seem to be less strong for modal quantification than they do for individual quantification. In English, for example, the paradigm *possible*, *necessary*, *impossible*, *unnecessary* fills all four corners of modal quantification. In French Sign Language, deontic '*not-all*' modals include the morphologically complex PAS-BESOIN (derived from universal affirmative BESOIN) as well as the morphologically simplex PAS-LA-PEINE. But neither English nor LSF has a single word to express 'not-all' for individual quantification.

The informativity hypothesis has the ability to explain such differences between quantificational domains. For example, there are many activities that people ought to do, but don't. Consequently, while (1b) is probably more surprising than (1a), the judgment for (2) is less clear. The modal *not required* will thus be more informative than the individual quantifier *not everybody*.

(1) a. John is required to help.
b. John is not allowed to help.

(2) a. Everybody helped.
b. Nobody helped.

If such facts hold generally across the verbal lexicon, they will affect lexicalization biases.

In contrast, on the markedness hypothesis, there is no difference between quantification over individuals, times, or worlds. In each case, the representation of a monotone decreasing operator is equally complex; there should thus be no differential effect between domains.

Experiment The informativity hypothesis is grounded on intuitions about the lexicon (specifically, the supposition that lexicalized properties generally hold of a minority of objects), but Enguehard & Spector (2021) do not test this assumption experimentally. We did so here. Subjects were asked to judge the degree to which the situations described by quantified statements were surprising, on a continuous scale from 'Not at all surprising' to 'Very surprising.' We tested 'All' (*everybody/always/required*) and 'None' (*nobody/never/not allowed*) for 75 of the most frequent English verbs and adjectives; on each screen, subjects judged two quantified sentences with the same predicate, as in (3). The experiment had one block for each domain: subjects saw the same predicates for quantification over individuals, times, and worlds.

(3) a. Everybody said something. Not at all surprising ..... Very surprising
b. Nobody said anything. Not at all surprising ..... Very surprising

The informativity hypothesis makes two predictions, shown in (4). First, if the general tendency to not lexicalize *not-all* arises from informativity, then *All* statements should usually be more surprising than *None* statements for each domain. Second, if the weakening of this tendency for the modal domain arises from informativity, then the difference in surprisingness of *Required* minus *Not allowed* should be less than that of *Everybody* minus *Nobody*.

(4) Prediction #1: $All_D > None_D$ for each domain D
Prediction #2: $All_{\text{world}} - None_{\text{world}} < All_{\text{indiv}} - None_{\text{indiv}}$

Results As shown in Figure 1, the experimental results manifestly did not confirm Prediction #1. For each domain, *None* statements were judged to be more surprising than *All* statements. But, as shown in Figure 2, Prediction #2 was borne out: the *All* − *None* measure was significantly lower for modal quantification than for individual (or temporal) quantification (on a Wilcoxon Signed-Rank test: $z = 2.9307, p = .00338$).

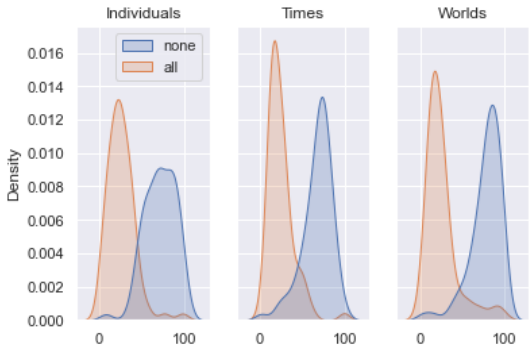

Figure 1: Distribution of surprisingness by item.

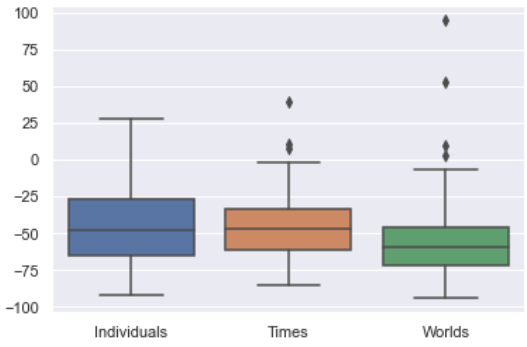

Figure 2: Box plots of *All* − *None* by item.

Discussion These results can be explained as arising from a combination of the two pressures. The experimental results show that *Not-all* statements are in fact usually more informative than *Some* statements. This suggests that any informativity bias (in favor of *not-all*) is overridden by a markedness bias (against *not-all*). On the other hand, evidence of an informativity bias emerges in the differential effects: *not-required* is even more informative than *not-everybody*, leading to exceptional lexicalization of *not-all* in the modal domain. Inspecting the data by item supports this interpretation: the trend appears to be driven by predicates like *help*, *understand*, and *be sure*, which carry a strong moral imperative that may not be satisfied in practice.

One notable finding is that the underlying supposition of the informativity hypothesis (above: 'more things are not purple than purple') doesn't actually hold for how people use language in practice. Certainly '*Everybody did the homework assignment*' is is very surprising if one quantifies over a random sample of

the 5000 students at a small college, but RELEVANCE plays a enormous role restricting the domain to just those individuals who are expected to do the homework.

Finally, more typological work is needed to establish the differential lexicalization tendencies. Useful examples may come from sign languages, which frequently show suppletive negative forms.

References Enguehard & Spector (2021). Explaining gaps in the logical lexicon of natural languages. *S&P*. • Horn (1973). *On the semantic properties of logical operators in English*. UCLA thesis. • Katzir & Singh (2013). Constraints on the lexicalization of logical operators. *L&P*.