Multiple pressures to explain the 'not all' gap*

Jeremy Kuhn
Institut Jean Nicod, ENS, CNRS, EHESS, PSL University

Lena Pasalskaya
Institut Jean Nicod, ENS, CNRS, EHESS, PSL University

Abstract Languages frequently lexicalize the quantifiers *all*, *some*, and *none*, but rarely lexicalize *not all*. Enguehard & Spector (2021) argue that this gap can be derived from probabilistic properties of the lexicon; on plausible assumptions, *some* is more informative, and thus more likely to be lexicalized, than *not all*. Here, we describe new predictions of this theory, which we test in an experimental setting. We present crosslinguistic data that suggests that the pressure to not lexicalize *not all* is weaker for modal quantification than for individual quantification, and show that this can be explained by the informativity hypothesis. We then experimentally measure probabilistic properties of the lexicon by asking subjects to evaluate the surprisingness of quantificational statements. The results suggest that informativity alone cannot explain the 'not all' gap, but support the hypothesis that it plays a role in the differences between quantificational domains.

Keywords: *Not all*, quantification, modality, language universals, information theory

1 The 'not all' gap

Aristotle's square of opposition consists of four quantificational statements, called A, I, E, and O, illustrated in the table in (1).

(1)

A	**E**
All *N*s are *P*	No *N*s are *P*
I	**O**
Some *N*s are *P*	Not all *N*s are *P*

Horn (1972) famously observes that, cross-linguistically, languages tend not to lexicalize the O-corner, 'not all'. English, for example, has the quantifiers *all*, *some*, and *none*, but there is no single lexicalized word meaning 'not all.' This generalization holds across languages: (2) shows a similar gap appearing in English, French, and Russian.

* We wish to thank Benjamin Spector, Emile Enguehard, Salvador Mascarenhas, Keny Chatain, Serpil Karabüklü, and audiences at GLOW 45 and ELM 2 for discussion and feedback on this work.

(2)

	A	I	E	O
a. English:	all	some	none	???
b. French:	tous	quelques	aucun	???
c. Russian:	vse	kto-to	nikto	???

A similar generalization also holds across domains of quantification, as illustrated in (3). In the temporal domain, English has the quantifiers *always*, *sometimes*, and *never*, but no single word meaning 'not always.' In the modal domain, English has a variety of auxiliaries instantiating the A and I corners (A: *must, should, ought*; I: *can, could, may, might*). Both E and O corners require morphologically complex auxiliaries, although there are arguably more ways to express E than O (notably, both *mustn't* and *can't* instantiate the E-corner, despite being derived from A and I respectively). We will revisit these generalizations in Section 2.

(3)

	A	I	E	O
a. Individuals:	all	some	none	???
b. Times:	always	sometimes	never	???
c. Worlds:	must	can	(mustn't, can't)	(needn't)

A slightly more nuanced version of the generalization can be given by defining a scale of syntactic complexity, as shown in (4). Simplest on this scale are morphologically simplex words, such as *all* or *some*. Next are morphologically complex words. For example, in English, *unnecessary* is created via affixation, and *needn't* is created via cliticization; both fill the 'not all' corner for modal quantification. Yet more complex are multi-word sequences which are nevertheless syntactic constituents; in English, for example, individual quantifiers can be directly modified by negation to form the constituents *not all* or *not every*. Finally, in languages like French, even this strategy is not possible; the 'not all' meaning must be communicated by negating the sentence as a whole.

(4) Morphologically simplex word: *all*, *some*
  < Morphologically complex word: *unnecessary*
   < Syntactically complex constituent: *not all*
    < Non-constituent: *Tous les étudiants ne dansent pas*. (French)
     Lit. 'All the students don't dance.'

In the context of this scale, a new generalization can be provided in implicative terms (Horn 1972): the 'not all' corner is at least as complex as the other three corners, and tends to be more complex.

Where does this typological bias come from? As a first step, Horn (1972) 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 pragmatically equivalent, so natural language does not need to lexicalize all four meanings—three corners of the square suffice. But this account is only half the story; if *some* and *not all* are pragmatically equivalent, then one must explain why languages typically lexicalize *all*, *none*, and *some*, instead of *all*, *none*, and *not all*.

A first possible explanation involves MARKEDNESS: monotone decreasing operators are just inherently more difficult than monotone increasing operators (Horn 1972, Katzir & Singh 2013). For example, Katzir & Singh (2013) propose that the only primitive operators are meet ($\sqcap$, *all*) and join ($\sqcup$, *some*), and that marked operators may be constructed as the negation of existing operators (e.g. *none* $= \neg$*some*). *Some* is thus less marked than *not all*, so more likely to be lexicalized. Katzir & Singh (2013) argue that this analysis has several additional advantages. First, they observe that it also rules out other unattested operators (*xor*, *iff*), which simply cannot be built by the system. Second, they argue that the morphological complexity of *none* seems independently motivated. In particular, the E-corner, though more likely to be lexicalized than the O-corner, nevertheless is generally more marked than A and I corners; for example, English has no morphologically simplex modal to express *can’t*, and even *none* and *never* can arguably be decomposed into *n-* plus an existential. Further evidence of this decomposition comes from split-scope effects in some languages, in which the negative and existential meanings take separate scope (Abels & Martí 2010). Example (5), for example, has a reading on which the company doesn’t have to fire any employees; the negative and existential components of *no* are thus ‘split’ by the modal: $\neg > \Box > \exists$.

(5) The company need fire no employees.

On the other hand, Enguehard & Spector (2021) observe that the markedness hypothesis remains fundamentally stipulative: there is no *a priori* reason why A and I are primitive and not the other two. For example, any one operator plus negation suffices to derive the other three meanings; the following sets are equivalent: {A, ¬A, A¬, ¬A¬} = {I, ¬I, I¬, ¬I¬} = {E, ¬E, E¬, ¬E¬} = {O, ¬O, O¬, ¬O¬}. Moreover, comparing *some* and *not all*, one observes that the verification strategies of the two are equally complex. Given a set of individuals that have a property (1) or not (0), *some* is true if one can find a 1; *not all* is true if one can find a 0.

Enguehard & Spector (2021) thus pursue an alternative hypothesis in terms of INFORMATIVITY. First, Enguehard & Spector observe that the decision of whether to use *some* or *not all* is influenced by probabilistic priors. In (6a), for example, it is perfectly fine to use the quantifier *not all*, but quite odd to use the quantifier *some*; example (6b) reverses these judgements with a different choice of predicate.

(6) a. Hey look, {$^?$some/not all} of the SALT talks are in English!

b. Hey look, {some/$^?$not all} of the SALT talks are in French!

What this example shows is that a probabilistic notion of informativity in fact breaks the *some*/*not all* equivalence. In general, a less likely proposition is more informative, so has greater utility.

Enguehard & Spector then assume that languages evolve to maximize overall utility (Gibson et al. 2019). The lexicalization bias is thus reduced to the following question: Over a language as a whole, which is more informative—*some* or *not all*? Following Chater & Oaksford (1999), Enguehard & Spector make the plausible assumption that lexicalized predicates in natural language tend to hold of a minority of objects. For example, more things are not blue than are blue; more people are not drunk than are drunk. Naturally, the example in (6) shows that these probabilistic priors vary across predicates, and antonym pairs (*alive* vs. *dead*; *on* vs. *off*) provide further predicates that will have exactly opposite priors. Nevertheless, Enguehard & Spector assume that, across the lexicon as a whole, *some* will be more informative than *not all*, and so will be lexicalized.

In this reply to Enguehard & Spector (2021), we describe and test new predictions of these theories. In Section 2, we provide new evidence of a differential bias across quantificational domains: the constraint is weaker for modality than for individuals or times. We show that this differential effect can be explained by informativity but not markedness. In Section 3, we experimentally test the probabilistic properties of the lexicon, in a paradigm in which subjects evaluate the surprisingness of quantificational statements. In Section 4, we discuss the results, and argue that they are best explained by a combination of markedness and informativity.

2 Differences between domains

In Section 1, we stated that the 'not all' generalization holds across domains of quantification. While this is true up to a point, the strength of the generalization appears to vary across quantificational domains. For individual and temporal quantification in English, the O-corner is the odd one out—it is the only corner that can't be spelled out with a single word. For modal quantification, on the other hand, there are a variety of ways that one can express the meaning 'not required.' The modal auxiliary *needn't* is a single word, and, although it is morphologically complex, it is no more complex than the words used to spell out the E-corner: *can't*, *mustn't*, or *shouldn't*. Similarly, the modal adjective *unnecessary* is a single word, exactly as complex as the E-corner adjective *impossible*. For both of these paradigms, the relevant generalization thus seems to oppose A and I on the one hand with E and O on the other. For modal verbs, there are monomorphemic forms that fill each corner of the square (e.g. *require*, *allow*, *forbid*, *exempt*), although Horn (1972) observes that O-corner modal verbs are nevertheless less frequent. Finally, the adjective *optional* is a monomorphemic lexical item that expresses an O-corner modal meaning. Embedding *optional* under negation in (8) confirms that the meaning of *optional* is indeed ‘not required’ (O $= \neg\Box p$) as opposed to ‘allowed to and allowed not to’ (I $\wedge$ O $= \Diamond p \wedge \Diamond\neg p$).

(7)

A	I	E	O
must	can	mustn’t, can’t	needn’t
necessary	possible	impossible	unnecessary
require	allow	forbid	exempt
			optional

(8) The concert is not optional...

a. ...You have to attend.

b. * ...You’re not allowed to attend.

Thus, while it may still be possible to distinguish the O-corner from the other three, the difference seems to be much less pronounced in English in the domain of modal quantification.

A similar weakening of the ‘not all’ gap can be found for modal quantification in other languages. Typologically, sign languages may be of particular interest, as they have been shown to frequently have suppletive negative forms (Zeshan 2004, Fernald & Napoli 2000). One such example is French Sign Language (LSF). In LSF, there is a large inventory of modal items, filling out all four corners of the square of opposition, as shown in (9). (We gloss LSF words with their closest French translation.)

(9)

A	I	E	O
FAUT	PEUT	FAUT.PAS	PAS.BESOIN
BESOIN	POSSIBLE	PEUT.PAS	PAS.LA.PEINE
OBLIGE	PERMIT	INTERDIT	

Notably, all of the examples in (9) are single words. Some of the negative forms are morphologically complex: FAUT.PAS is the negative form of FAUT; PEUT.PAS is the negative form of PEUT; PAS.BESOIN is the negative form of BESOIN. As seen in Figure 1, PAS-BESOIN differs from BESOIN only in its movement, shared with other irregular negative verbs. Other negative modals—INTERDIT and PAS.LA.PEINE—have no positive counterparts. The O-corner in LSF thus includes two (deontic) modals: the morphologically complex PAS.BESOIN as well as the apparently morphologically simplex PAS.LA.PEINE.

This pattern contrasts with quantification over individuals or times. For neither individual nor temporal quantification is there a single lexical item in LSF that

Figure 1 a. BESOIN; b. PAS.BESOIN; c. PAS.LA.PEINE in LSF

expresses the O-corner, as shown in (10). The pressure against lexicalization the O-corner thus is found for individuals and times, but disappears or decreases in the modal domain.

(10)

	A	I	E	O
a. Individuals:	CHAQUE	QUELQU'UN	AUCUN	???
	TOUS		RIEN	
b. Times:	TOUJOURS	PARFOIS	JAMAIS	???

Finally, LSF is not the only sign language to have O-corner modals. In both Russian Sign Language (L. Pasalskaya, p.c.) and Turkish Sign Language (S. Karabüklü, p.c.), a morphologically complex item meaning 'not required' is derived from the negation of a universal modal. And in Sign Language of the Netherlands, the item HOEFT-NIET is a deontic O-corner modal with no positive counterpart (E. Khristoforova, p.c.).

Across all of these examples, it thus appears that the pressure against the O-corner, while still perhaps present in some form, is systematically *weaker* for modal quantification than for individual or temporal quantification.

Assuming that this differential effect is indeed real, we observe that no explanation is possible on the markedness hypothesis. In all quantificational domains, the O-corner is equally complex: $\neg\sqcap$. There is thus no way to derive differential effects between domains.

In contrast, the informativity hypothesis is able to explain the differences across domains. For example, there are many activities that people ought to do, but don’t. To take one clear example, consider the predicate *floss one’s teeth*. We take flossing to be an activity that dentists systematically recommend, but which few individuals actually do regularly. In this context, the modal statement in (11a) is not at all surprising, and (11b) is very surprising. In contrast, when quantifying over individuals, these judgments flip: the statement in (12a) is very surprising, and the statement in (12b) not at all.

(11) a. John is required to floss his teeth.
b. John is not allowed to floss his teeth.

(12) a. Everybody flossed their teeth.
b. Nobody flossed their teeth.

What this example shows is that one and the same predicate may have different probabilistic properties depending on the domain of quantification. With the predicate above, *not required* is more informative than *not everybody*. If such facts hold generally across the verbal lexicon, they will affect lexicalization biases.

3 Experiment

Enguehard & Spector (2021) do not attempt to empirically establish statistical properties of the lexicon, demurring that the relevant statistical assumption ‘is very hard to assess based on actual data.’ On the other hand, we find that judgments about surprisingness can be quite clear; for example, ‘*All the SALT talks are in French*’ clearly describes a surprising situation! The clearness of these judgments thus offers the possibility of testing lexical priors directly.

This was the strategy adopted in an experimental paradigm. By asking subjects’ intuitions for some of the most common English predicates, we aimed to establish (a) overall tendencies of the lexicon and (b) differences between quantificational domains.

3.1 Methods

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* statements (A: *everybody/always/required*) and *None* statements (E: *nobody/never/not allowed*) for 75 of the most frequent English verbs and adjectives.

Since O and I are the negations of A and E, their corresponding probabilities can be similarly derived: $P(\mathrm{O}) = 1 - P(\mathrm{A})$ and $P(\mathrm{I}) = 1 - P(\mathrm{E})$. Testing the surprisingness of *All* and *None* thus allowed us to test the informativity of *Some* and *Not all* while avoiding the use of the target expressions themselves, and thus avoid any biases introduced by the higher morphological complexity of *Not all* statements.

Predicates sampled the most frequent English verbs and adjectives, as specified by the Corpus of Contemporary American English. Several lexical items were not included, for which it was difficult to create quantificational sentences, such as *be*, *become*, and *let*. The tested predicates included 75 items consisting of 71 verbs and 4 adjectives, shown in (13). Transitive and ditransitive verbs were presented with an indefinite in object position(s).

(13) add, ask, be free, be late, be right, be sure, begin, believe, bring, build, buy, call, change, come, consider, continue, create, do, expect, feel, find, follow, get, give, go, hear, help, hold, hope, include, keep, know, lead, learn, leave, like, live, look, lose, love, make, meet, move, need, offer, pay, play, provide, put, read, remember, run, say, see, send, show, sit, spend, stand, start, stop, take, talk, tell, thank, think, try, turn, understand, use, wait, want, watch, work, write

Subjects were divided into three groups that each saw a third of the predicates. On each screen, subjects judged two quantified sentences with the same predicate, as in (14). The experiment had one block for each domain: subjects saw the same 25 predicates for quantification over individuals, times, and worlds. The order of the blocks and the order of the items in each block was randomized.

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

(15) a. John is required to say something.
b. John is not allowed to say anything.

(16) a. John always says something.
b. John never says anything.

Six control sentences (two per block) were included as exclusion items. These items were manually selected as predicates with especially clear judgments; e.g. (17a) is more surprising than (17b). Answers were considered incorrect if the score was more than 25 (out of 100) for unsurprising controls, or less than 75 for surprising controls. Subjects were excluded if they had more than one incorrect answer on control items.

(17) Control sentence for modal quantification block

a. John is required to lie.
b. John is not allowed to lie.

Participants were solicited via Prolific. In total 22 participants were included for analysis (an additional 8 were excluded by the control sentences).

3.2 Hypotheses and results

Two predictions were tested. First, if the ‘not all’ gap is explained entirely by informativity, then we make the prediction that *All* statements should be more surprising than *None* statements, across all domains of quantification, as stated in (18).

(18) Prediction #1: $All_D > None_D$ for each domain D

Second, if the weakening of this effect for modals is explained by informativity, then *required* should be less surprising compared to *everybody* relative to the baseline values for *not allowed* and *nobody*, as stated in (19). Specifically, if *required* is relatively less surprising (i.e. more likely) than *everybody*, then the O-corner *not required* will be relatively more informative, and thus more likely to be lexicalized, than the O-corner *not everybody*.

(19) Prediction #2: $All_{\text{world}} - None_{\text{world}} < All_{\text{indiv}} - None_{\text{indiv}}$

As shown in Figure 2, the experimental results manifestly did not confirm Prediction #1. For each domain, *None* statements were judged to be more surprising than *All* statements. For example, ‘Nobody said anything’ is judged as *more* surprising than ‘Everybody said something.’ For 71 out of the 75 tested predicates, this result holds for all three quantificational domains. (The four exceptions are *be late* (i, t, w), *lose something* (i, w), *take something* (t, w), and *run* (i, t, w).)

On the other hand, as shown in Figure 3, Prediction #2 was borne out: the *All* − *None* measure was significantly lower for modal quantification than for individual or temporal quantification. For 49 out of 75 predicates, *All* − *None* was lower for modal quantification than individual quantification (on a Wilcoxon Signed-Rank test: $z = -2.9307, p = .00338$). For 53 out of 75 predicates, *All* − *None* was lower for modal quantification than temporal quantification (on a Wilcoxon Signed-Rank test: $z = -3.67, p = .00024$). No significant difference was found between individual and temporal quantification (on a Wilcoxon Signed-Rank test: $z = -1.2741, p = .20408$).

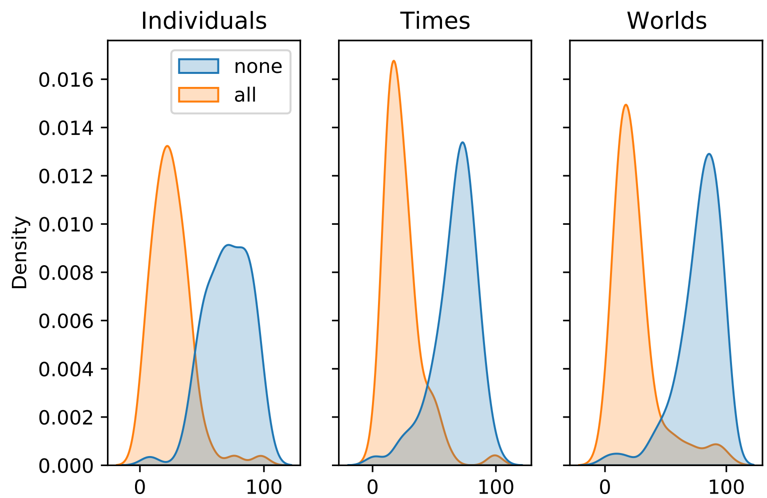

Figure 2 Distribution of surprisingness by item, with 100 = 'very surprising.'

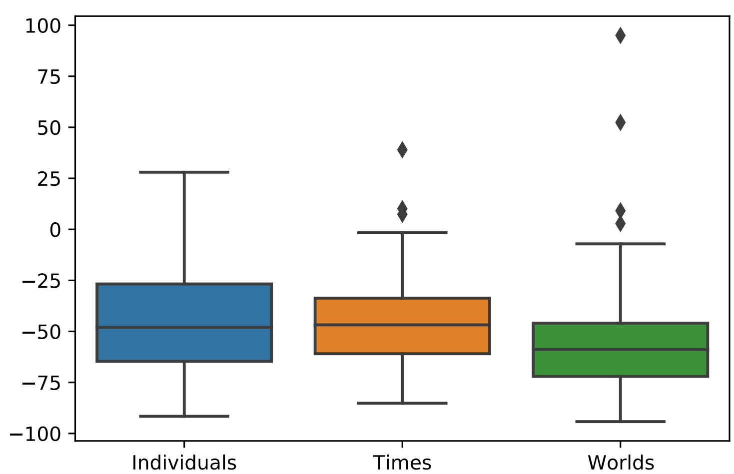

Figure 3 Box plots of *All* − *None* by item.

4 Discussion

4.1 Markedness + informativity

These results can be explained as arising from a combination of markedness and informativity.

First, the main effect can be explained by markedness. The experimental results (perhaps surprisingly) show that *None* statements are more surprising than *All* statements, so *Not all* should in fact have higher utility than *Some* from the point of view of informativity. However, this preference from informativity is overridden by a markedness bias against *Not all*.

Second, the differential effects can be explained by informativity: *not required* is even more informative than *not everybody*, leading to exceptional lexicalization of the O-corner in the modal domain. Inspecting the data by item supports this interpretation: the difference between domains is driven by predicates like *understand*, *be sure*, and *help*, which carry a strong moral imperative that may not be satisfied in practice. For example, (20b) is much more surprising than (20a), but the judgment for (21) is less clear. As a result, an O-corner modal is particularly informative for this predicate and others like it, and can be used very naturally in a sentence like (22).

(20) a. John is required to understand.
b. John is not allowed to understand.

(21) a. Everybody understood.
b. Nobody understood.

(22) You don’t need to understand, just do it!

4.2 The role of relevance

As discussed in detail above, Enguehard & Spector’s analysis is grounded in the assumption that predicates tend to hold of a minority of individuals. When considering predicates in isolation, this assumption seems extremely plausible; more people are not drunk than are drunk. There may be mathematical justifications for the validity of this assumption, as well. As obseved by Chater & Oaksford (1999), many nouns, verbs, and adjectives describe mutually exclusive properties within a category—for example, *dog*, *cat*, *bird* or *blue*, *red*, *yellow*. As a consequence, most such predicates necessarily hold of a minority of individuals. *All* statements should thus generally be more surprising than *None* statements.

In light of these facts, the experimental findings here are rather surprising: across the board, we find exactly the opposite—*None* statements are judged as more surprising than *All* statements. One possible explanation is that the sample of predicates that we tested is not in fact representative of the full English lexicon. For example, because the study was designed to include only frequent predicates, it may have included a disproportionate number of underspecified verbs like *do*, which hold of a majority of individuals. A similar such bias may be introduced by using an indefinite quantifier (*something*/*anything*) as the object of transitive verbs. However, while this may be a contributing factor, it can't be the full story. As reported above, the experimental generalization holds overwhelmingly across almost all predicates (71 out of 75), including predicates with specific meanings and no indefinite quantifier, such as *pay*, *read*, and *sit*.

Rather, we propose that the results found here reflect an important role of RELEVANCE in surprisingness judgments. Consider the examples in (23). Over a random sample of 5000 students at a small college, the predicate *do the homework assignment* certainly holds of a minority of individuals. Nevertheless, the very use of this predicate causes the listener to restrict the domain of quantification to a small subset of these individuals—those who are expected to do the homework. Despite the prevalent probabilistic properties at the college in question, (23b) is intuitively more surprising than (23a).

(23) a. Everybody did the homework assignment.
b. Nobody did the homework assignment.

Similar reasoning intuitively applies to our experimental items. For example, at any given moment, the predicate *pay* applies to a minority of individuals. However, the only individuals for whom it is relevant to use the predicate are those who have received some goods or service; among this subset of individuals, the predicate applies to the great majority, thus making (24b) more surprising than (24a).

(24) a. Everybody paid.
b. Nobody paid.

This being said, we note that relevance itself is likely governed by information-theoretic processes (Kao et al. 2014, Rohde et al. 2022). The discussion above perhaps suggests an overly simplistic model on which domain restriction occurs via a black box called 'relevance,' after which the utility of *not all* is calculated via priors on the new domain. In actuality, though, it is much more likely that both processes (calculation of relevance and of utility) occur in parallel, and that both are sensitive to probabilistic effects. We leave it as an open question how such a system might affect lexicalization biases, especially as this may depend on the precise model in question. In light of this uncertainty, then, it remains a possibility that a viable account of the 'not all' gap may still be found that is stated fully in terms of informativity, without the additional assumption of markedness.

Finally, we observe that, whatever the contribution of relevance, it doesn’t provide any obvious way to explain the observed differences across quantificational domains. The experimental results thus seem to detect a true difference between domains, with observable consequences for the typological generalization on the informativity hypothesis.

4.3 Beyond deontic modals

One of the objectives of the present paper has been to unpack a monolithic generalization. In previous literature, the ‘not all’ gap is stated as a generalization about quantification in general. Here, we have shown that the typological landscape may vary in interesting and predictable ways, depending on the domain in question.

It may be possible to take this endeavor a step further. Notably, modal quantification can be further decomposed into different modal flavors—epistemic, deontic, among others—that themselves vary with respect to the domain of quantification. On a classic account, epistemic modality quantifies over worlds that are compatible with the speaker’s knowledge; deontic modality quantifies over worlds compatible with the rules or laws.

In the present experiment, all judgments involved statements of deontic modality, but there are reasons, both theoretical and typological, to believe that there may be differences between deontic and epistemic modal flavors. First, typologically, we observe that none of the O-corner modals that we have observed allow an epistemic modal flavor. In English, for example, (25) may perhaps be used with a teleological meaning (e.g. there are other reasons besides rain for the event to be canceled), but cannot be used to communicate the epistemic statement that it might not be raining. In (26a), the adverb *necessarily* can be used with epistemic flavor (‘the evidence points to John’), but the adverb *unnecessarily* in (26b) can only be given an odd teleological or deontic meaning (‘the situation was avoidable’). Similarly, in French Sign Language, PAS-BESOIN and PAS-LA-PEINE allow deontic and teleological interpretations, but not epistemic uses.

(25) It needn’t rain.

(26) a. John is necessarily the murderer.
b. ? John is unnecessarily the murderer.

On the theory in terms of informativity, there may be an explanation of these facts. Notably, epistemic modality, relating to knowledge of the world, is much more closely linked to the probabilistic properties of individual or temporal quantification than is deontic modality. For example, the epistemic statement ‘It must be raining’ arguably entails that it is raining. But, as we have seen, the deontic statement ‘John is required to do his homework' certainly does not entail that he actually does it. Typological differences between epistemic and deontic modals may then arise from the same probabilistic properties that distinguish deontic modality from individual or temporal quantification.

Indeed, this observation may have broader relevance for the syntax and semantics of modality. Of note, one well known observation is that not all modal flavors take the same scope with respect to negation—roughly speaking, epistemic modals tend to scope above negation, while deontic modals tend to scope below it. These observations have motivated grammatical proposals about the structural position at which different modals appear in the syntax (Cinque 1999). We leave it as an open question whether some of these scopal preferences can be derived from biases related to informativity.

5 Conclusion

In the present paper, we discussed the 'not all' gap in the context of recent work built on the notion of informativity (Enguehard & Spector 2021). We described new predictions of this theory, which we tested in an experimental setting.

On the typological front, we provided preliminary evidence of a differential bias across quantificational domains. Analytically, we showed that such differences between domains can be explained on a theory involving informativity. We then provided the results of an experiment in which we approximated probablistic properties of the lexicon. We argued that the results are explainable by a combination of markedness and informativity.

Looking forward, we believe that there is plenty of room for further typological work (including in sign languages). By moving from a monolithic generalization to the more nuanced view espoused here, one can get a richer understanding not only of *whether* there is a typological gap, but *what processes* underlie it.

References

Abels, Klaus & Luisa Martí. 2010. A unified approach to split scope. *Natural Language Semantics* 18(4). 435–470.

Chater, Nick & Mike Oaksford. 1999. The probability heuristics model of syllogistic reasoning. *Cognitive Psychology* 38(2). 191–258. http://dx.doi.org/10.1006/cogp.1998.0696.

Cinque, Guglielmo. 1999. *Adverbs and functional heads: A crosslinguistic perspective* Oxford Studies in Comparative Syntax. Oxford, New York: Oxford University Press.

Enguehard, Émile & Benjamin Spector. 2021. Explaining gaps in the logical lexicon of natural languages: A decision-theoretic perspective on the square of aristotle. *Semantics and Pragmatics* 14(4). http://dx.doi.org/10.3765/sp.14.5.

Fernald, Theodore B. & Donna Jo Napoli. 2000. Exploitation of morphological possibilities in signed languages: Comparison of american sign language with english. *Sign Language & Linguistics* 3(1). 3–58. http://dx.doi.org/10.1075/sll.3.1.03fer.

Gibson, Edward, Richard Futrell, Steven T. Piantadosi, Isabelle Dautriche, Kyle Mahowald, Leon Bergen & Roger Levy. 2019. How efficiency shapes human language. *Trends in cognitive sciences* 23(5). 389–407. http://dx.doi.org/10.1016/j.tics.2019.02.003.

Horn, Laurence R. 1972. *On the semantic properties of logical operators in english*: University of California, Los Angeles dissertation.

Kao, Justine T., Jean Y. Wu, Leon Bergen & Noah D. Goodman. 2014. Nonliteral understanding of number words. *Proceedings of the National Academy of Sciences* 111(33). 12002–12007. http://dx.doi.org/10.1073/pnas.1407479111.

Katzir, Roni & Raj Singh. 2013. Constraints on the lexicalization of logical operators. *Linguistics and Philosophy* 36(1). 1–29. http://dx.doi.org/10.1007/s10988-013-9130-8.

Rohde, Hannah, Jet Hoek, Maayan Keshev & Michael Franke. 2022. This better be interesting: A speaker’s decision to speak cues listeners to expect informative content. *Open mind* .

Zeshan, Ulrike. 2004. Hand, head, and face: Negative constructions in sign languages. *Linguistic Typology* 8. 1–58. http://dx.doi.org/10.1515/lity.2004.003.

Word count: 4709