Searching for a universal constraint on the possible denotations of clause-embedding predicates*

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1 Introduction

• One of the central questions in semantic research is whether there are any universal constraints on the possible denotations of lexical items of a certain grammatical category.

• This question has been investigated most prominently in the domain of determiners like every, most, and some.

• For instance, it has been proposed that all determiners are ‘conservative’ and that all monomorphemic determiners are ‘monotonic’ (Barwise and Cooper, 1981).

• Recent work has explored possible semantic universals in the domain of clause-embedding predicates like know, agree, and wonder (Spector and Egré, 2015; Theiler et al., 2018; Uegaki, 2019; Steinert-Threlkeld, 2019).

• Within this line of work, two basic questions can be distinguished:
  – The first is empirical: Which constraints, if any, do we find in the semantics of clause-embedding predicates?
  – The second is theoretical: What may explain the existence of such universal semantic constraints?

• The present paper is primarily concerned with the first question. It also engages with the second question, but does not have the ambition to make a major contribution on this front.

*This is a draft of a handout to be presented at Semantics and Linguistic Theory (SALT), which will be held as an online event mid August 2020. We welcome comments on any aspect of the proposal.
• More specifically, we will critically review a number of recent proposals which put forward possible constraints that relate the meaning of a clause-embedding predicate when it takes an interrogative complement to its meaning when it takes a declarative complement (Spector and Egré, 2015; Theiler et al., 2018; Uegaki, 2019).

• We will argue that each of these proposals has counterexamples.

• Then, we will identify a constraint, P-TO-Q DISTRIBUTIVITY, which is exception-free w.r.t. available cross-linguistic data and yet significant in the sense that it rules out many conceivable denotations which have so far not been attested in cross-linguistic research.

• Roadmap:
  – §2 discusses existing proposals.
  – §3 evaluates these proposals in light of some new empirical observations.
  – §4 formulates and defends a new semantic constraint, P-TO-Q DISTRIBUTIVITY.
  – §5 briefly turns to the question why clause-embedding predicates might be subject to a constraint like P-TO-Q DISTRIBUTIVITY.
  – §6 discusses a number of cases which might at first sight appear to be counterexamples to P-TO-Q DISTRIBUTIVITY, but on closer inspection are compatible with it.
  – §7 concludes.

2 Existing proposals

2.1 Verdical Uniformity

• Spector and Egré (2015) note that the semantics of clausal embedding should ideally account for the lack of certain fictitious verbs in the vocabulary of any language.

• An example they give of such a fictitious verb is *shknow*, which would mean ‘know’ with a declarative clause and ‘wonder’ with an interrogative clause.

• Another example, considered by Steinert-Threlkeld (2019), is the fictitious verb *knopinion*, which would mean ‘be opinionated about’ with a declarative complement and ‘know’ with an interrogative complement.

• S&E suggest that these are instances of a general pattern. Specifically, they propose that all responsive predicates are uniform w.r.t. veridicality (adopting terminology from Steinert-Threlkeld (2019)).

• A responsive predicate is uniform w.r.t. veridicality if and only it is
  – either veridical w.r.t. both declarative and interrogative complements,
– or non-veridical w.r.t. both declarative and interrogative complements.

- A predicate \( V \) is veridical w.r.t. declarative complements if and only if for every declarative complement \( p \), if \( x Vs p \) is true then \( p \) must be true as well.

- For instance, \( \text{know} \) is veridical because if \( \text{Mary knows that Bill left} \) is true then it must be the case that Bill left.

- Defining veridicality w.r.t. interrogative complements is somewhat less straightforward.

- We follow Theiler et al. (2018) in defining this notion only in terms of so-called ‘exhaustivity-neutral’ interrogative complements.

- It is widely discussed in the literature that interrogative complements often allow for multiple readings that differ in the level of exhaustivity (non-exhaustive, weakly exhaustive, intermediate exhaustive, strongly exhaustive).

- Exhaustivity-neutral interrogative complements are ones for which such a multitude of readings does not arise.

- Typical examples include polar interrogative complements such as \( \text{whether Bill left} \) and wh-interrogative complements with a uniqueness presupposition such as \( \text{which boy left} \).

- For such exhaustivity-neutral interrogative complements it is clear what the pieces of information are that resolve the issue expressed by the interrogative in a minimal way, i.e., without providing any unnecessary information.

- We refer to declarative complements expressing such resolutions as answers. For instance, \( \text{that Bill left} \) and \( \text{that Bill didn’t leave} \) are the answers to \( \text{whether Bill left} \).

- A predicate \( V \) is veridical w.r.t. interrogative complements if and only if for every exhaustivity-neutral interrogative complement \( Q \) and any answer \( p \) to \( Q \), if \( x Vs Q \) is true and \( p \) is true, then \( x Vs p \) must be true as well.

- For instance, \( \text{know} \) is veridical w.r.t. interrogative complements because if \( \text{Mary knows whether Bill left} \) is true and if Bill did in fact leave, then \( \text{Mary knows that Bill left} \) must be true as well.\(^1\)

\(^1\) As pointed out in Theiler et al. (2018), if we had not restricted ourselves to exhaustivity-neutral complements in the definition of veridicality w.r.t. interrogative complements, then \( \text{know} \) would have been classified as non-veridical. To see this, consider the following example, in which the complement has a salient non-exhaustive (mention-some) reading.

(i) Rudolph knows where one can buy an Italian newspaper.

Suppose that Rudolph knows that one can get an Italian newspaper at Newstopia, and that he does not falsely believes that one can get Italian newspapers elsewhere. Further suppose that in fact Italian newspapers are sold both at Newstopia and at Paperworld. Then, on the one hand, (i) is true on a non-exhaustive reading. On the other hand, \( \text{that one can get an Italian newspaper at Paperworld} \) is an answer to the embedded interrogative (still assuming a non-exhaustive reading). But (ii) is false, violating the requirement for
The generalisation proposed by Spector and Egré (2015) can now be formulated as follows.

1. **Veridical Uniformity Universal**
   All responsive predicates are uniform w.r.t. veridicality.

2. **Veridical Uniformity**
   A responsive predicate is uniform w.r.t. veridicality if and only if it is either veridical w.r.t. both declarative and interrogative complements, or non-veridical w.r.t. both declarative and interrogative complements.

- *shknow* is veridical w.r.t. declarative complements, but non-veridical w.r.t. interrogatives.
- *knopinion* is non-veridical w.r.t. declarative complements, but veridical w.r.t. interrogatives.

### 2.2 C-distributivity and the Choice property

- Theiler et al. (2018) propose two other properties that clause-embedding predicates tend to have:

3. **C-distributivity**:
   A clause-embedding predicate $V$ is C-DISTRIBUTIVE just in case for any term $x$ and any ‘exhaustivity-neutral’ interrogative complement $Q$ (e.g., ‘who won the race’), $x Vs Q$ is true iff there is an answer $p$ to $Q$ such that $x Vs that p$.

4. **Choice Property**:
   A declarative-embedding predicate $V$ has the choice property just in case for any two mutually inconsistent declarative complements $p$ and $p'$, $x Vs that p$ and $x Vs that p'$ cannot be true at the same time.

- Theiler et al. (2018) show that C-DISTRIBUTIVITY and the CHOICE PROPERTY are related to VERIDICAL UNIFORMITY as follows:

  - Any C-DISTRIBUTIVE predicate that is veridical w.r.t. declaratives is also veridical w.r.t. interrogatives.
  - Any C-DISTRIBUTIVE predicate that has the CHOICE PROPERTY and is veridical w.r.t. interrogatives is also veridical w.r.t. declaratives.
  - So, C-DISTRIBUTIVITY and the CHOICE PROPERTY together imply VERIDICAL UNIFORMITY.

(ii) Rudolph knows that one can buy an Italian newspaper at Paperworld.
• However, as Theiler et al. note, predicates of relevance (PoRs) (e.g., care, matter) are counterexamples to both VERIDICAL UNIFORMITY and C-DISTRIBUTIVITY.

  – They are counterexamples to VERIDICAL UNIFORMITY because they are veridical w.r.t. declarative complements but not w.r.t. interrogative complements.
  – They are counterexamples to C-DISTRIBUTIVITY since the inference in (5) is invalid (Elliott et al., 2017):

  $\text{(5)} \quad \text{Ann cares about who won. } \not\exists \quad \text{There is someone s.t. Ann cares that they won.}$

• Note that the CHOICE PROPERTY only pertains to the meaning of clause-embedding predicates when taking a declarative complement.

• Our main interest here is in constraints that relate the meaning of a clause-embedding predicate when it takes an interrogative complement to its meaning when it takes a declarative complement.

• We will therefore not be concerned with the CHOICE PROPERTY.\(^2\)

2.3 Strawson C-distributivity

• Uegaki (2019) notes that it is the presuppositional component of predicates of relevance that makes them counterexamples to C-DISTRIBUTIVITY.

• To see this, consider the following formal analysis of care, based on Elliott et al. (2017) and Theiler et al. (2018):

  $\text{(6)} \quad [\text{care}]^w = \lambda Q \lambda x : \text{DOX}_x^w \subseteq \bigcup Q. \exists p \in \text{alt}(Q) : \text{BOU}_x^w \subseteq p \lor \text{BOU}_x^w \cap p = \emptyset$

where:

  – We take a complement clause $Q$, be it declarative or interrogative, to denote a set of propositions.
  – If $Q$ is declarative, its denotation contains only one alternative; if it is interrogative, its denotation contains multiple alternatives;
  – $\text{DOX}_x^w$ is the doxastic state of $x$ in $w$, that is, the set of worlds that $x$ considers possible in $w$;
  – $\text{BOU}_x^w$ is the bouletic state of $x$ in $w$, that is, the set of worlds compatible with $x$‘s preferences in $w$.

\(^2\)Let us just note, however, that the CHOICE PROPERTY is not a truly universal property. For instance, be possible, be allowed, and be uncertain lack the CHOICE PROPERTY. The Slovenian predicate dopuščati ‘allow for the possibility’, discussed by Močnik (2019), does as well.
• This analysis correctly predicts that (7) has a very weak presupposition (Ann believes that one of the answers to 'who won' is true), while (8) has a much stronger presupposition (Ann believes that $x$ won).

(7) Ann cares about who won.
(8) Ann cares that $x$ won.

• Because of this, (7) can be true even if, for no $x$, the presupposition of (8) are satisfied.

• This is why C-DISTRIBUTIVITY fails for predicates of relevance.

• Uegaki (2019) proposes a weaker notion of C-DISTRIBUTIVITY for which PoR are not counterexamples. This weaker notion is inspired by the notion of Strawson entailment in the literature on NPI licensing (von Fintel, 1999), so we will refer to it as STRAWSON C-DISTRIBUTIVITY.

• STRAWSON C-DISTRIBUTIVITY filters out cases of presupposition failure: it requires that if $x$ Vs $Q$ is true then there is an answer $p$ to $Q$ such that if the presuppositions of $x$ Vs that $p$ are met, then $x$ Vs that $p$ is true.

• On the other hand, just like plain (non-Strawson) C-DISTRIBUTIVITY, it also requires that if there is an answer $p$ to $Q$ such that $⌜x$ Vs that $p⌝$ is true, then $⌜x$ Vs $Q⌝$ is true.\(^3\)

(9) STRAWSON C-DISTRIBUTIVITY
A clause-embedding predicate $V$ is STRAWSON C-DISTRIBUTIVE just in case for any term $x$ and any 'exhaustivity-neutral' interrogative complement $Q$ (e.g., 'who won the race'):

a. If $⌜x$ Vs $Q⌝$ is true then there is an answer $p$ to $Q$ such that, if the presuppositions of $x$ Vs that $p$ are satisfied, then $⌜x$ Vs that $p⌝$ is true.

b. If there is an answer $p$ to $Q$ such that $⌜x$ Vs that $p⌝$ is true, then $⌜x$ Vs $Q⌝$ is true.

• To see that this rules in predicates of relevance, suppose that (7) is true, i.e., Ann cares about who won.

\(^3\)In fact, Uegaki (2019) does not include this second requirement, so his actual constraint is weaker than what we call STRAWSON C-DISTRIBUTIVITY here. We do not see empirical support for this weakening at this point, so we keep the constraint as strong as possible, while ensuring compatibility with predicates of relevance. To make this more concrete, though without going into great detail, let us note that the constraint as formulated in Uegaki (2019) does not rule out the artificial predicate $knopinion$ defined in Steinert-Threlkeld (2019). Roughly, this predicate has a meaning similar to be opiniated about when taking a declarative complement, and a meaning similar to know when taking an interrogative complement. To our knowledge, predicates with such a semantic profile have not been found in any languages so far. Moreover, Steinert-Threlkeld's artificial language learning experiment shows that the semantics of this predicate is harder to learn than that of predicates like know and be certain. This suggests that a suitable semantic universal should rule it out.
Then, according to the entry for care, there must be an individual $x$ such that Ann’s preferred worlds are all ones where $x$ won, or all ones where $x$ did not win.

But this means that for that individual $x$—as long as the presupposition of (8) is satisfied, i.e., as long as Ann believes that $x$ won—(8) is true, i.e., Ann cares that $x$ won.

So condition (9a) is satisfied.

### 2.4 Possible explanations

- We’ve so far seen a number of empirical generalizations. But why would there be a tendency for clause-embedding predications across languages to conform to such generalizations?
- Concretely, why is that there aren’t many predicates, if any at all, that are not Veridical Uniform and/or (Strawson) C-distributive?
- Two hypotheses have been proposed:
  - **Simplicity / Easy verification** There is an easy (distributive) strategy to verify whether a sentence of the form $x \ Vs \ Q$ is true if the predicate $V$ is C-distributive. Namely, we can consider sentences of the form $x \ Vs \ that \ p$, for all answers $p$ to $Q$, and as soon as we find that one of these sentences is true, we know that $x \ Vs \ Q$ is true as well. Perhaps, in the course of language evolution, clause-embedding predicates that permit such a verification strategy are favoured over ones that don’t (Theiler et al., 2018).
  - **Learnability** It may be that the meaning of Veridical Uniform / C-distributive predicates is easier to learn that that of predicates which do not have this property. Some preliminary evidence for this hypothesis is presented in Steinert-Threlkeld (2019).

- Note that these two hypotheses are not necessarily independent. In particular, it may be that C-distributive predicates are relatively easy to learn because they permit an easy verification strategy.

### 3 New observations

- **Strawson C-distributivity** remains problematic as a universal constraint, in view of Estonian contemplative verbs (e.g., mõtlema) (Roberts, 2018), the Japanese sentence-final particle daroo (Hara, 2018; Uegaki and Roelofsen, 2018), as well as inquisitive predicates like wonder and inquire. We discuss each of these in turn.

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4Related to this, Szymanik and Thorne (2017) show that there is a correlation between the complexity of quantifiers (in terms of the type of automata that is needed for their verification) and their frequency in corpora.
3.1 Estonian mõtlema

- **Roberts (2018)** presents a detailed investigation of the Estonian verb *mõtlema*.
- *mõtlema* can take both declarative and interrogative complements.
- **Roberts (2018)** observes that when ϕ is a declarative complement, x *mõtlema* ϕ has two possible interpretations:
  - x believes that ϕ is true.
  - x does not believe ϕ but imagines what the world would be like if it were true.
- These two interpretations are exemplified in (10) and (11), respectively:

  (10) Liis mõtleb, et sajab vihma, aga ei saja.
  Liis MÕTLEMA that falls rain but NEG fall.NEG
  ‘Liis thinks that it’s raining, but it isn’t raining.’

  (11) Context: *I am discussing with my friend what life would be like if an asteroid had not collided with the earth at the end of the late Cretaceous period.*

  Ma mõtlen, et dinosaurused on ikka elus, kuigi ma tean, et
  I MÕTLEMA that dinosaurs are still alive although I know that
  ei ole.
  NEG be.NEG
  ‘I’m thinking about dinosaurs still being alive, even though I know that they aren’t.’

- When ϕ is an interrogative complement, x *mõtlema* ϕ also has two possible interpretations:
  - x wonders what the answer to ϕ is.
  - for some answer p to ϕ, x does not believe p but imagines what the world would be like if it were true.
- These first interpretations is exemplified in (12) while the second interpretation in (13)-(14):

  (12) Ma mõtlen, kes ukse taga on.
  I think.1SG who door.GEN behind is
  ‘I wonder who is at the door.’

  (13) Context: *Liis hears a knock at the door. She was expecting her friend Kirsi to come over, but she fantasizes for just a moment all the famous celebrities who could be showing up instead.*
Liis mõtleb, kes ukse taga on, kuigi ta teab, et on Kirsi. Liis thinks who door.Gen behind is although she knows that is Kirsi ‘Liis is thinking about who is at the door, even though she knows, that it is Kirsi.’

(14) Context: Siim is reading a book about Estonian history. It got him thinking about all the reasons there were for Estonia to lose the war with Russia in the 1500s.

Siim mõtleb, miks Eesti kaotas sõja.
Siim thinks why Estonia lost war
‘Siim is thinking about why Estonia lost the war.’

• To see that this predicate violates C-DISTRIBUTIVITY consider a context in which:
  – Mary doesn’t know whether it is raining.
  – She wants to know whether it’s raining.
  – She is not imagining what the world would be like if it were or were not raining.

• Now consider the following statements:

(15) Mary mõtlemawhether it is raining.

(16) a. Mary mõtlemat hat it is raining.
    b. Mary mõtlemat hat it isn’t raining.

• In the given context, according to Roberts’ empirical discussion:
  – (15) is true (on the ‘wonder’ reading)
  – (16a) is false (on either the ‘believe’ or the ‘imagine’ reading)
  – (16b) is false (on either the ‘believe’ or the ‘imagine’ reading)

• This means that mõtlemat violates C-DISTRIBUTIVITY.

• It violates STRAWSON C-DISTRIBUTIVITY as well since presuppositions do not play a role in the counterexample above.

• Roberts (2018) notes that mõtlemat is not alone in this kind of behavior in Estonian: similar patterns can be observed with mõtisklemat ‘consider’, vaatlemat ‘observe’, and meelisklemat ‘muse’.

• He also mentions that the Finnish verb miettiä, a presumed cognate of mõtlemat, displays the same sort of behavior.
3.2 Japanese *daroo*

- The Japanese sentence-final particle *daroo*, discussed by Hara (2018) and Uegaki and Roelofsen (2018), also constitutes a counterexample to C-DISTRIBUTIVITY.

- *daroo* can have either a declarative or an interrogative prejacent.

- With a declarative prejacent, its meaning is similar to *think*.

  \[(17)\] Ken-wa utau *daroo*.
  Ken-TOP sing DAROO
  ‘I think that Ken will sing.’

- With an interrogative prejacent, its meaning is similar to *wonder* (a subtle difference with *wonder* will be discussed later but is not relevant here yet).

  \[(18)\] Ken-wa utau *daroo*-ka.
  Ken-TOP sing DAROO-Q
  ‘I wonder whether Ken will sing.’

- To see that *daroo* violates C-DISTRIBUTIVITY consider a context in which:
  - Mary has no idea whether Ken will sing.
  - She would like to know whether Ken will sing.

- In such a context, Mary can truthfully utter (18) but not (17), nor a variant of (17) in which the prejacent is negated.

- This shows that *daroo* violates C-DISTRIBUTIVITY.

- STRAWSON C-DISTRIBUTIVITY is violated as well since presuppositions do not play a role here.

3.3 Inquisitive predicates

- Inquisitive predicates (e.g., *wonder, inquire*) also constitute a challenge for C-DISTRIBUTIVITY, though at a somewhat different level than predicates like *daroo* and mōtešma.

- Since *wonder* and *inquire* are rogative, i.e., they only take interrogative complements, we might simply assume that a constraint like C-DISTRIBUTIVITY do not apply to such predicates, since the constraint makes reference to cases in which the predicate applies to a non-inquisitive semantic value.

- In principle, however, it would be preferable to think of the constraint as applying across clause-embedding predicates, without making reference to selectional restrictions.

10
• This is indeed possible if, following Theiler et al. 2018 and Uegaki 2019, we assume that rogative predicates like wonder are of the same semantic type as responsive predicates like know.

• For concreteness, let us consider the entry for wonder.

(19) \[[\text{wonder}]^w = \lambda Q \lambda x. \text{DOX}^w_x \not\in Q \land \text{INQ}^w_x \subseteq Q\]

where:

– We take an interrogative complement $Q$ to denote a set of propositions, namely those propositions that resolve the issue expressed by $Q$;

– $\text{DOX}^w_x$ is the doxastic state of $x$ in $w$, that is, the set of worlds that $x$ considers possible in $w$;

– $\text{INQ}^w_x$ is the inquisitive state of $x$ in $w$, that is, the set of extensions of $\text{DOX}^w_x$ in which the issues that $x$ entertains in $w$ are resolved.

• The entry says that $x$ wonders $\phi$ is true in $w$ just in case (i) $x$’s doxastic state is not an element of the semantic value of $\phi$, which means that it does not resolve the issue expressed by $\phi$, and (ii) $x$’s inquisitive state is contained in the semantic value of $\phi$, which means that $x$ would like to reach a doxastic state which does resolve the issue expressed by $\phi$.

• Importantly, $\phi$ can in principle be a declarative complement. However, in this case, the two conjuncts in the entry for wonder always contradict each other.

• That is, the entry predicts that, when $\phi$ is a declarative complement, $x$ wonders $\phi$ is always contradictory. This is precisely how the selectional restrictions of wonder are accounted for.

• On such an account, it is possible to evaluate whether wonder satisfies C-DISTRIBUTIVITY.

• The answer is that it does not. After all, $x$ wonders $Q$ can be true even if for every answer $p$ to $Q$, $x$ wonders $p$ is false. The latter, in fact, is inescapable.

Interim summary

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<thead>
<tr>
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<th>*shknow</th>
<th>*knopinion</th>
<th>care</th>
<th>mōtlema</th>
<th>daroo</th>
<th>wonder</th>
</tr>
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where ✓ means ‘correct prediction’ and ✗ ‘incorrect prediction’.
4 Proposal

- We propose to weaken C-DISTRIBUTIVITY by limiting it to the direction from declarative-embedding to interrogative-embedding, as in (21).

\[(21) \quad \text{P-TO-Q DISTRIBUTIVITY}\]
A clause-embedding predicate $V$ is P-TO-Q DISTRIBUTIVE if and only if for any term $x$ and any ‘exhaustivity-neutral’ interrogative complement $Q$, if there is an answer $p$ to $Q$ such that $x \text{Vs that } p$, then $x \text{Vs } Q$ is true.

\[(22) \quad \text{P-TO-Q DISTRIBUTIVITY UNIVERSAL}\]
All clause-embedding predicates $V$ are P-TO-Q DISTRIBUTIVE.

- Since P-TO-Q DISTRIBUTIVITY is weaker than C-DISTRIBUTIVITY, all predicates that satisfy the latter (e.g., know, predict, surprise) satisfy the former as well.

- Furthermore, P-TO-Q DISTRIBUTIVITY rules in cases that are problematic for C-DISTRIBUTIVITY: predicates of relevance, mōtelema, daroo, and inquisitive predicates. We will consider these in Sections 4.2-4.5, respectively.

- Finally, P-TO-Q DISTRIBUTIVITY still rules out fictitious predicates like shknow and knopinion. These are discussed in Section 4.6.

- Before discussing these predictions in detail, we will first, in Section 4.1, provide a more precise formulation of P-TO-Q DISTRIBUTIVITY.

4.1 Formalization

- We will provide a formalization of P-TO-Q DISTRIBUTIVITY in Inquisitive Semantics (Ciardelli et al., 2018).

- Inquisitive Semantics provides a uniform treatment of declarative and interrogative complements, making it easy to define P-TO-Q DISTRIBUTIVITY in a concise way.

- But, a similar formalization could be given in Hamblin semantics (Hamblin, 1973).

- In Inquisitive Semantics, the semantic value of clause $\varphi$, $[\varphi]$, is construed as the set of those propositions that:

  (i) resolve the issue that $\varphi$ expresses (if any); and

  (ii) do not contain any possible worlds that are ruled out by the information that $\varphi$ conveys (if any).

- The set of propositions associated with a clause construed this way is always downward closed. That is, if $[\varphi]$ contains a proposition $p$ then it must also contain any stronger proposition $q \subset p$. 
• For any set of propositions $Q$ we will write $Q^\downarrow$ for the set of propositions $p$ which are contained in some $q \in Q$:

$$(23) \quad Q^\downarrow := \{ p \mid p \subseteq q \text{ for some } q \in Q \}$$

• For example:

$$(24) \begin{align*}
\text{a. } & \left[ \text{that Ann left} \right] = \left\{ w \mid \text{Ann left in } w \right\}^\downarrow \\
\text{b. } & \left[ \text{whether Ann left} \right] = \left\{ w \mid \text{Ann left in } w \right\}, \left\{ w \mid \text{Ann didn’t leave in } w \right\}^\downarrow
\end{align*}$$

• The maximal elements of $\left[ \varphi \right]$ are those propositions that contain precisely enough information to resolve the issue expressed by $\left[ \varphi \right]$.

• For any set of propositions $Q$ we will write $\text{alt}(Q)$ for such maximal elements of $Q$:

$$(25) \quad \text{alt}(Q) := \{ p \in Q \mid \text{there is no } q \in Q \text{ s.t. } p \subset q \}$$

• With this background, we can formalize P-TO-Q DISTRIBUTIVITY as follows:

$$(26) \quad \text{P-TO-Q DISTRIBUTIVITY (formalized)}$$

A predicate $V$ of type $\langle \langle st; t \rangle; \vec{et} \rangle$ is P-TO-Q DISTRIBUTIVE if and only if for any term $x$ and any exhaustivity-neutral $Q$, if there is a $p \in \text{alt}(Q)$ such that $\left[ V \right](\{ p \}^\downarrow)(x)$, then $\left[ V \right](Q)(x)$.

$$(27) \quad \text{P-TO-Q DISTRIBUTIVITY UNIVERSAL (formalized)}$$

All clause-embedding predicates $V$ of type $\langle \langle st; t \rangle; \vec{et} \rangle$ are P-TO-Q DISTRIBUTIVE.

• NB: Here, we give an inquisitive semantic treatment of complements (with type $\langle st; t \rangle$), but give a traditional treatment of matrix sentential denotation (with extension of type $t$). This is merely for expository purposes.

### 4.2 Care

• First, note that care empirically satisfies P-TO-Q DISTRIBUTIVITY, as seen by the validity of the following inference (regardless of the subject and the interrogative complement).

$$(28) \quad \text{There is an answer } p \text{ to ‘who won’ s.t. } \text{Ann cares that } p \Rightarrow \text{Ann cares (about) who won.}$$

• This is captured by P-TO-Q DISTRIBUTIVITY together with the formal analysis of care that we gave before, based on Elliott et al. (2017) and Theiler et al. (2018):

$$(29) \quad \left[ \text{care} \right]^w = \lambda Q_{(st,t)} \lambda x_e: \text{DOX}_x^w \subseteq \bigcup Q. \exists p \in \text{alt}(Q) : \text{BOU}_x^w \subseteq p \lor \text{BOU}_x^w \cap p = \emptyset$$
• (29) satisfies P-TO-Q DISTRIBUTIVITY as defined in (26). This is so because, for any term \( x \) and any exhaustivity-neutral \( Q \), the following holds:
  
  - Suppose there is a \( p \in \text{alt}(Q) \) s.t. \([\text{care}]^w(\{p\}^\dagger)(x)\).
  
  - Given (29), this is the case iff (i) \( \text{DOX}_x^w \subseteq p \) and (ii) \( \text{BOU}_x^w \subseteq p \lor \text{BOU}_x^w \cap p = \emptyset \)
  
  - Since \( p \subseteq \bigcup Q \), (i) entails that \( \text{DOX}_x^w \subseteq \bigcup Q \).
  
  - Since \( p \in \text{alt}(Q) \), (ii) entails that \( \exists p \in \text{alt}(Q) : \text{BOU}_x^w \subseteq p \lor \text{BOU}_x^w \cap p = \emptyset \)
  
  - Taken together, (i) and (ii) entail \([\text{care}]^w(Q)(x)\).

4.3 Daroo

• Recall: the Japanese particle daroo means ‘think’ when it takes a declarative complement and something similar to ‘wonder’ when it takes an interrogative complement.

• Hara 2018 and Uegaki and Roelofsen 2018 analyze the semantics of daroo as follows, simplifying irrelevant details:

\[
[\text{daroo}]^w = \lambda x (st,t). \text{INQ}_{sp}^w \subseteq Q \\
\text{(sp: the speaker)}
\]

• Recall from the semantics of wonder we have given in (19) above that \( \text{INQ}_x^w \) is the inquisitive state of \( x \) in \( w \), that is, the set of extensions of \( \text{DOX}_x^w \) in which the issues that \( x \) entertains in \( w \) are resolved.

• We first motivate this analysis of daroo empirically, and then move on to show that it satisfies P-TO-Q DISTRIBUTIVITY.

• (30) captures the fact that \( p \)-daroo, with a declarative complement \( p \), simply means ‘the speaker believes \( p \)’:

\[
[p \text{ daroo}]^w = 1 \text{ iff } \text{INQ}_{sp}^w \subseteq \{p\}^\dagger \\
\text{iff } \text{DOX}_{sp}^w \subseteq p
\]

• When (31) takes an interrogative complement \( Q \), \( Q \)-daroo is predicted to mean that the speaker entertains the issue represented by \( Q \):

\[
[Q \text{ daroo}]^w = 1 \text{ iff } \text{INQ}_{sp}^w \subseteq Q
\]

• Above, we have stated that daroo roughly means ‘wonder’ when it takes an interrogative complement. However, the analysis in (32) is crucially different from that of wonder-\( Q \) according to the semantics we have given above in (19):

\[
[\text{wonder } Q]^w = \lambda x. \text{DOX}_x^w \not\subseteq Q \land \text{INQ}_x^w \subseteq Q
\]

• The crucial difference is that daroo lacks the ignorance component—\( \text{DOX}_x^w \not\subseteq Q \)—which exists in wonder.
• The lack of the ignorance component in the semantics of *daroo* is motivated in view of the following kind of examples:

(34) **Huji-santyoo-de-wa mizu-wa nando-de huttoo-suru daroo-ka.**

Mt.Fuji-top-LOC-TOP water-TOP what.degree-in boil-do DAROO-Q
Huji-santyoo-de-wa kiatsu-ga tijoo-no sanbunnoni
Mt.Fuji-top-LOC-TOP air.pressure-NOM ground.level-GEN two-thirds
kurai nanode, mizu-wa yaku 87.7 do de huttoo-suru.
about because water-TOP about 87.7 °C at boil-do
‘At what temperature does water boil at the top of Mt. Fuji? Since the air pressure there is about 2/3 of the ground level, it boils at about 87.7°C.’

• Here, the author/speaker uses *Q-daroo* to introduce the question *Q* as a topic, which she in fact knows the answer to. This suggests that *Q-daroo* does not semantically entail the speaker’s ignorance about *Q*.5

• This is in contrast to the behavior of *wonder*, which is infelicitous in a similar context:

(35) #I wonder at what temperature water boils at the top of Mt. Fuji. Since the air pressure there is about 2/3 of the ground level, it boils at about 87.7°C.

• The lack of the ignorance component furthermore captures the fact that *daroo* is **responsive**, i.e., compatible with both declarative and interrogative complements. If *daroo* carried the ignorance component in its semantics, we would expect it to be **rogative** just like *wonder*, i.e., be incompatible with declarative complements due to the predicted contradiction in meaning.

• Now that we have motivated the semantics of *daroo* in (30), let us see its prediction w.r.t. P-TO-Q DISTRIBUTIVITY.

• (30) satisfies P-TO-Q DISTRIBUTIVITY as defined in (26). This is so because, for any exhaustivity-neutral *Q*, the following holds:

– Suppose there is a *p* ∈ alt(*Q*) s.t. \([\text{daroo}]_w(\{p\}^\downarrow)(x)\).
– Then, by (30), we have that INQ\( _p^w \subseteq \{p\}^\downarrow\).
– Now, since *p* ∈ alt(*Q*), we have that \{p\}^\downarrow ⊆ *Q*.
– Thus, INQ\( _p^w \subseteq \{p\}^\downarrow\) holds only if INQ\( _p^w \subseteq \{p\}^\downarrow\).
– Taken together, \([\text{daroo}]_w(\{p\}^\downarrow)(x)\) entails \([\text{daroo}]_w(\{p\}^\downarrow)(x)\)

### 4.4 *Mõtlema*

• As discussed above, Roberts (2018) gives the following empirical description of the behavior of *mõtlema*.

---

5Although *Q-daroo* may pragmatically implicate ignorance as a result of competition with *p-daroo*, where *p* is a specific answer of *Q*, as suggested by Uegaki and Roelofsen (2018).
• When $\phi$ is a **declarative** complement, $x \text{ mõtlema } \phi$ has two possible interpretations:
  – $x$ believes that $\phi$ is true.
  – $x$ does not believe $\phi$ but imagines what the world would be like if it were true.

• When $\phi$ is an **interrogative** complement, $x \text{ mõtlema } \phi$ also has two possible interpretations:
  – $x$ wonders what the answer to $\phi$ is.
  – for some answer $p$ to $\phi$, $x$ does not believe $p$ but imagines what the world would be like if it were true.

• Theoretically, Roberts (2018) proposes that the semantics of mõtlema makes reference to what he calls the **contemplation state** of the subject.

• The contemplation state of an agent is defined as a set of questions (each modelled as a partition of a set of contextually relevant possible worlds). These questions are ones that are ‘under active consideration’ by the agent.

• The contemplation state of $x$ in $w$ is denoted as $\text{CONT}_x^w$.

• The semantics of mõtlema is then proposed to be as follows:

\[
\text{[mõtlema]}_w^w = \lambda Q \lambda x. Q \in \text{CONT}_x^w
\]

• Roberts assumes that both declarative and interrogative complements denote sets of propositions. In the case of a declarative complement this is a singleton set, in the case of an interrogative complement the set contains multiple propositions.

• The ‘questions’ in an agent’s contemplation states can also be singleton sets, corresponding to the meaning of a declarative complement.

• While this proposal may be a possible starting point, it would have to be further articulated in order to make clear predictions.

• In particular, what needs further elaboration is what it means for a (possibly singleton) partition to be ‘under active consideration’ by an agent.

• Further specifying this would also yield formal constraints on contemplation states.

• For instance, if a certain question $Q$ is in the contemplation state of an agent $x$, does it follow that every sub-question of $Q$ is also in $x$’s contemplation set? Or that every singleton subset of $Q$ (each corresponding to an exhaustive resolution) is in $x$’s contemplation set? Or, perhaps, that at least two of these singleton subsets are (in case $Q$ is not a singleton to begin with)?

• For a more concrete example, suppose that the question in (37) is under active consideration for $x$: 

16
(37) Is Mary in London or in Paris?

Does it then follow that (38) and/or (39) are also under active consideration?

(38) Is Mary in London?

(39) Mary is in London.

• For the account to make clear predication, these questions need to be resolved. In other words, the ‘logic’ of contemplation needs to be specified.

• This would be an interesting project to further pursue, but we do not see at this point how it could be done in such a way that the reported readings could be captured in a fully uniform way.

• We therefore, for now, we will specify a semantics for mõtlema which, while capturing the reported readings, is not fully uniform.

• More precisely, staying close to the basic empirical pattern that Roberts (2018) reports, we assume that mõtlema has two readings:

  – On its daroo reading, it says that the subject ‘entertains’ the issue expressed by the complement (in a sense to be made more precise below).

  – On its imagine reading, it says that there is an answer to the issue expressed by the complement such that the subject imagines what the world would be like if it were true.

• This is reflected in the disjunctive lexical entry below, where $\text{IMG}_x^w$ is the set of worlds that are compatible with what $x$ imagines to be the case in $w$.

\[
(40) \quad [\text{mõtlema}]^w = \lambda Q_{(st,t)} \lambda x_e. \quad \text{INQ}_x^w \subseteq Q \quad \lor \quad \exists p \in \text{alt}(Q) : \text{IMG}_x^w \subseteq p
\]

• ‘daroo’

• ‘imagine’

• Having fixed this semantic analysis of mõtlema, we can now ask whether it is P-TO-Q DISTRIBUTIVE.

• Suppose that $Q$ is an exhaustivity-neutral question and $p$ an answer to $Q$ such that $x$ mõtlema $p$ is true.

• On the daroo reading, this means that $x$ believes $p$. Then it follows that $x$ mõtlema $Q$ is true as well on the daroo reading.

• On the imagine reading, it means that $x$ does not believe $p$ but imagines what the world would be like if $p$ were the case. But then it follows that $x$ mõtlema $Q$ is true as well on the imagine reading.

• So, indeed, mõtlema is P-TO-Q DISTRIBUTIVE.
• Recall from Section 3.1 that mõtlema is not C-DISTRIBUTIVE. This is because it is not Q-TO-P DISTRIBUTIVE, as the examples discussed in Section 3.1 show (the formal entry given above is in accordance with the readings assumed in these examples).

4.5 Wonder

• Finally, wonder as analyzed below, repeated from §3.3 above satisfies P-TO-Q DISTRIBUTIVITY as well.

\[(\text{wonder})^w = \lambda Q_{(st,t)} \lambda x. \text{DOX}_x^w \not\subseteq Q \land \text{INQ}_x^w \subseteq Q\]

• This is so since \[(\text{wonder})^w (\{p\}^1(x))\] is false for any \(x\) and \(p\) and thus P-TO-Q DISTRIBUTIVITY is trivially satisfied.

4.6 Non-attested predicates

• We have seen that P-TO-Q DISTRIBUTIVITY rules in predicates of relevance, mõtlema, daroo, and inquisitive predicates.

• At the same time, P-TO-Q DISTRIBUTIVITY is still significant in the sense that it rules out many conceivable but non-attested meanings.

**all-open**

• First consider the fictitious predicate in (42), meaning ‘to consider all possibilities open’:

\[(\text{all-open})^w = \lambda Q \lambda x. \forall p \in \text{alt}(Q) : \text{DOX}_x^w \cap p \neq \emptyset\]

• This predicate violates P-TO-Q DISTRIBUTIVITY, because it is possible for DOX\(_x^w\) to be compatible with some \(p \in \text{alt}(Q)\) without being compatible with all \(p \in \text{alt}(Q)\).

• To our knowledge, this prediction is correct, i.e., no language lexicalizes (42).

• More generally, this seems true for all predicates that quantify universally over the alternatives in the denotation of their complement. This (prima facie unexpected) general restriction is predicted by P-TO-Q DISTRIBUTIVITY.

**wondows**

• Next, consider the following fictitious predicate, discussed by Steinert-Threlkeld (2019):

\[\text{wondows}^w = \lambda Q \lambda x. \left( \begin{array}{c} w \in \text{DOX}_x^w \land \text{DOX}_x^w \subseteq \text{info}(Q) \land \forall p \in \text{alt}(Q) : \text{DOX}_x^w \cap p \neq \emptyset \end{array} \right)\]

where \(\text{info}(Q) = \bigcup Q\) (i.e., the informative content of \(Q\))
• Steinert-Threlkeld (2019) describes this predicate as roughly meaning *know* when taking a declarative complement, while meaning *be uncertain* when taking an interrogative complement.

• The first and the second requirement posed by *wondows* are that $x$’s doxastic state does not rule out the actual world $w$ and that it supports the informative content of $Q$.

• The third requirement corresponds to that posed by *all-open*.

• *wondows* is therefore ruled out by P-TO-Q DISTRIBUTIVITY on similar grounds as *all-open*: it is possible for a belief state to, besides being truthful and supporting $\text{info}(Q)$, be compatible with some $p \in \text{alt}(Q)$ without being compatible with all $p \in \text{alt}(Q)$.

**shknow**

• Now let us turn to *shknow*, the fictitious predicate originally considered by Spector and Egré (2015).

• One way to formulate the lexical entry of *shknow* is as follows:

$$[\text{shknow}]^w = \lambda Q \lambda x. \left( \begin{array}{c}
w \in \text{DOX}_x^w \land \\
\text{DOX}_x^w \subseteq \text{info}(Q) \land \\
\forall p \in \text{alt}(Q) : \text{DOX}_x^w \cap p \neq \emptyset \land \\
\text{INQ}_x^w \subseteq Q \end{array} \right)$$

• Note that the first three requirements are those of *wondows* (encoding knowledge when combined with a declarative complement and uncertainty when combined with an interrogative complement).

• The fourth requirement adds an essential component of the meaning of *wonder*, namely that the subject wants to reach an epistemic state in which the issue expressed by the complement is resolved.

• This predicate also violates P-TO-Q DISTRIBUTIVITY, still essentially because of the requirement stemming from *all-open*.

• We should note that the *all-open* requirement forces a very strong level of ignorance (compatibility with all alternatives).

• Intuitively, it is possible for $x$ to wonder, say, who won the race, even if $x$ can already rule out some possible winners (see Cremers et al., 2019, for relevant experimental results).

• Given that *shknow* is intended to mean *wonder* when taking an interrogative complement, one may want to adapt the entry in (44), so as to make room for a weaker ignorance requirement.
• One way to do so is as in (45).\(^6\)

\[
\text{[shknow]}^w = \lambda Q \lambda x. \left( (|alt(Q)| = 1 \land \text{DOX}_x^w \in Q) \lor (|alt(Q)| \neq 1 \land \text{DOX}_x^w \notin Q \land \text{INQ}_x^w \subseteq Q) \right)
\]

• Under this analysis, shknow still violates P-TO-Q DISTRIBUTIVITY.

• This is because, for any \(Q\) and any \(p \in \text{alt}(Q)\), if \([\text{shknow}]^w(\{p\})^i(x)\) is true, then \([\text{shknow}]^w(Q)(x)\) is false due to the weak ignorance requirement that applies when it takes an interrogative complement (shown within a rectangle).

• Recall that daroo has a semantics that is quite similar to shknow. So the question arises why daroo satisfies P-TO-Q DISTRIBUTIVITY while shknow violates it.

• The reason for this is that daroo, unlike shknow, does not semantically entail ignorance when combined with an interrogative complement.

• Recall from §4.3 above that daroo-Q only pragmatically implicates ignorance due to competition with daroo-p.

**knopinion**

• Finally, let us consider the fictitious predicate knopinion, discussed in Steinert-Threlkeld (2019).

• Intuitively, this predicate means know when taking an interrogative complement and be opinionated when taking a declarative complement.

• Steinert-Threlkeld (2019) gives the following lexical entry:

\[
\text{[knopinion]}^w = \lambda Q \lambda x. w \in \text{DOX}_x^w \land (\text{DOX}_x^w \in Q \lor \text{DOX}_x^w \in \neg Q)
\]

where \(\neg Q := \{p \mid \forall q \in Q : q \cap p = \emptyset\}\)

• To see that this predicate does not satisfy P-TO-Q DISTRIBUTIVITY, suppose that Mary truly believes that Bill is not win the race. Then (47) is true while (48) is false.

| (47) Mary knopinions that Bill won the race. | true |
| (48) Mary knopinions who won the race. | false |

\(^6\)Note that the entry in (45) makes explicit reference to the cardinality of \(\text{alt}(Q)\). As far as we can see, it is not possible to achieve the same result without making such reference to \(|\text{alt}(Q)|\). We suspect that there may be a universal constraint on the denotation of clause-embedding predicates which prohibits such irreducible reference to \(|\text{alt}(Q)|\), but we leave open here how such a constraint should be formulated exactly and how it could be tested.
• So we have found a subject $x$, an exhaustivity-neutral $Q$ and an answer $p$ to $Q$ such that $\gamma x \text{kno}\text{preferences} \ p^\top$ is true while $\gamma x \text{kno}\text{preferences} \ Q^\top$ is false. This means that P-TO-Q DISTRIBUTIVITY is violated.

4.7 Formal connection with VERIDICAL UNIFORMITY

• Recall from Section 2.2 that Theiler et al. (2018) established the following connections between C-DISTRIBUTIVITY, the CHOICE PROPERTY, and VERIDICAL UNIFORMITY:

  – Any C-DISTRIBUTIVE predicate that is veridical w.r.t. declaratives is also veridical w.r.t. interrogatives.
  – Any C-DISTRIBUTIVE predicate that has the CHOICE PROPERTY and is veridical w.r.t. interrogatives is also veridical w.r.t. declaratives.
  – So, C-DISTRIBUTIVITY and the CHOICE PROPERTY together imply VERIDICAL UNIFORMITY.

• How does P-TO-Q DISTRIBUTIVITY relate to VERIDICAL UNIFORMITY?

• Any P-TO-Q DISTRIBUTIVE predicate that has the CHOICE PROPERTY and is veridical w.r.t. interrogatives is also veridical w.r.t. declaratives. The proof of this is a straightforward adaptation of the one in Appendix B.3 of Theiler et al. (2018).

• However, it is not the case that any P-TO-Q DISTRIBUTIVE predicate that is veridical w.r.t. declaratives is also veridical w.r.t. interrogatives. Counterexamples include predicates of relevance.

5 Remarks on the why question

• Recall that in Section 2.4 we briefly mentioned two hypotheses concerning the question why there would be a tendency for clause-embedding predications across languages to have properties like VERIDICAL UNIFORMITY and C-DISTRIBUTIVITY.

  – Simplicity / Easy verification If a predicate $V$ is C-distributive, then there is an easy (distributive) strategy to verify whether a sentence of the form $x \text{Vs} Q$ is true. Namely, we can consider sentences of the form $x \text{Vs} \ that \ p$, for all answers $p$ to $Q$, and as soon as we find that one of these sentences is true, we know that $x \text{Vs} Q$ is true as well. Perhaps, in the course of language evolution, clause-embedding predicates that permit such a verification strategy are favoured over ones that don’t (Theiler et al., 2018).

  – Learnability It may be that the meaning of Veridical Uniform / C-distributive predicates is easier to learn that that of predicates which do not have this property. Some preliminary evidence for this hypothesis is presented in Steinert-Threlkeld (2019).
• We also noted in Section 2.4 that these two hypotheses are not necessarily independent. In particular, it may be that C-distributive predicates are relatively easy to learn because they permit an easy verification strategy.

• Now, let us consider these hypotheses in light of P-TO-Q DISTRIBUTIVITY.

• First, note that if a predicate $V$ is only P-TO-Q DISTRIBUTIVE (and not C-DISTRIBUTIVE), then the verification strategy described above is still sound, but not complete. That is, there may be true sentences of the form $\forall x V s Q$, which the strategy would not identify as true sentences.

• What does this mean for the plausibility of the hypothesis?
  - A pressure favouring predicates facilitating simple verification strategies cannot, at least not by itself, explain the fact that all predicates (to our knowledge so far) are P-TO-Q DISTRIBUTIVE.
  - However, it still is a possible explanation of the fact that predicates tend to be (though not without exceptions) C-DISTRIBUTIVE.
  - And since all C-DISTRIBUTIVE predicates are also P-TO-Q DISTRIBUTIVE, it may still be considered a partial explanation of the P-TO-Q DISTRIBUTIVITY universal.

• Now let us turn to the Learnability hypothesis.

• To test this hypothesis, Steinert-Threlkeld (2019) carried out an experiment in which a neural network had to learn the meaning of four predicates:
  - know and be certain, both satisfying VERIDICAL UNIFORMITY and C-DISTRIBUTIVITY.
  - knopinion and wondows, both violating VERIDICAL UNIFORMITY and C-DISTRIBUTIVITY.

• He found that knopinion and wondows were significantly more difficult to learn than know and be certain.

• This result provides preliminary evidence for the hypothesis that predicates satisfying VERIDICAL UNIFORMITY and C-DISTRIBUTIVITY are easier to learn than ones that don’t.

• But what are the repercussions for P-TO-Q DISTRIBUTIVITY?

• We have already seen that knopinion and wondows violate P-TO-Q DISTRIBUTIVITY.

• Thus, the results of the experiment are compatible with the hypothesis that predicates satisfying P-TO-Q DISTRIBUTIVITY are easier to learn than ones that don’t.

• An interesting extension of Steinert-Threlkeld’s experiment would be to compare the learnability of
  - predicates that satisfy only P-TO-Q DISTRIBUTIVITY (i.e., not Q-TO-P DISTRIBUTIVITY) (like care, or believe info(Q), or wonder) with
(fictitious) predicates that satisfy only Q-TO-P DISTRIBUTIVITY (*knopinion* and *all-open* are of this kind, *wondows* violates both).

- If we were to find that the former are easier to learn than the latter, this would provide evidence for the idea that P-TO-Q DISTRIBUTIVITY, rather than the broader C-DISTRIBUTIVITY, is relevant for learnability.

6 Potential counterexamples

6.1 Communication predicates

- Karttunen (1977) argued that communication predicates like *tell* are veridical w.r.t. interrogative but not w.r.t. declarative complements.

(49) Mary told Bill what she bought.  
     Mary bought a new bike.  
     \[ \models \text{Mary told Bill that she bought a new bike.} \]

(50) Mary told Bill that she bought a new bike.  
     \[ \not\models \text{Mary bought a new bike.} \]

- If this is correct, then *Mary told Bill that she bought a new bike* does not entail *Mary told Bill what she bought*. For it may be that Mary lied about what she bought.

- But then, communication predicates like *tell* would be problematic for P-TO-Q DISTRIBUTIVITY.

- However, Tsohatzidis (1993) and Spector and Egré (2015) show that communication predicates do not always receive a veridical interpretation when taking an interrogative complement, based on examples like the following.

(51) Every day, meteorologists tell the population what the weather will be the next day, but they are often wrong.

- One can draw either of the following conclusions from this observation:

  1. Communication predicates are not veridical w.r.t. interrogative complements at all.

  2. Communication predicates are ambiguous. On one reading, they are veridical w.r.t. interrogative complements, but on the other reading they are not (Spector and Egré, 2015).\footnote{Uegaki (2015) adopts this assumption and proposes that the preference for the veridical reading w.r.t. interrogatives can be explained in terms of the Strongest Meaning Hypothesis (Dalrymple et al., 1998) (cf. Mayr, 2019).}

- On either of these hypotheses, communication predicates satisfy P-TO-Q DISTRIBUTIVITY.
6.2 Explain

• (Pietroski, 2000) and Elliott (2016) argue that when explain takes a declarative complement, this complement does not describe the ‘explanandum’—what is being explained—but rather the content of the explanation, i.e., the ‘explanans’. This is illustrated in (52b).

(52) a. Bill asked Mary why she wanted to leave.
    b. Mary explained that she wasn’t feeling well.

• (52b) does not report that Mary was explaining the fact that she wasn’t feeling well. Rather, she explained why she wanted to leave. The content of the explanation was that she wanted to leave because she wasn’t feeling well.

• By contrast, if explain takes an interrogative complement, this complement always describes the explanandum rather than the content of the explanation.8

(53) Mary explained how she was feeling.

• This sentence reports that Mary gave an explanation of her feelings, not that she described her feelings in order to explain something else, e.g., why she wanted to leave.

• Based on these examples, it may seem that explain violates P-TO-Q DISTRIBUTIVITY.

• After all, (52b) does not entail (53). The former conveys that Mary explained why she wanted to leave, namely because she wasn’t feeling well. But this does not entail that she gave an explanation of her feelings.

• However, before concluding that explain violates P-TO-Q DISTRIBUTIVITY, we first have to better understand how the verb combines with declarative and interrogative complements.

• The discussion in Elliott (2016) is relevant here, although it does not contrast declarative complements with interrogative ones, but rather declarative complements with DP arguments, as in (54).

(54) Mary explained the fact that she wasn’t feeling well.

• In this sentence, the DP argument of the verb describes the explanandum, just like in (53), rather than the content of the explanation.

• To derive the contrast between cases like (52b) and (54), Elliott (2016) suggests that declarative complements are modifiers of an event description, while DPs are

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8Pietroski (2000) and Elliott (2016) are mainly concerned with the contrast between cases in which explain combines with a declarative clause and ones in which it takes a DP argument. To our knowledge, there is no detailed investigation of cases in which explain takes an interrogative complement.
thematic arguments. In other words, the DP fills one of the argument slots of the verb, while a declarative complement does not function as an argument here but modifies the verb meaning.

- If an account of the contrast between (52b) and (54) on the bases of such a combinatorial difference is on the right track, then it may be extended to capture the the contrast between (52b) and (53) as well.

- We would have to assume that interrogative complements, like DPs, fill an argument slot of the verb. Whatever fills this argument slot always describes the explanandum, not the content of the explanation.

- On such an account, the fact that (52b) fails to entail (53) does not imply that *explain* violates P-TO-Q DISTRIBUTIVITY. After all, in (52b) the predicate does not take the declarative clause as its argument. Only clauses that describe the explanandum (rather than the content of the explanation) fill the argument slot of the predicate.

- There is, however, a bit more to say here.

- While (Pietroski, 2000) and Elliott (2016) assume that declarative complements always describe the content of the explanation, it is in fact also possible for them to describe the explanandum. This is illustrated in (55a-b).

\[(55)\]
\[
\begin{align*}
\text{a.} & \quad \text{I have already informed the television networks to reserve time on that evening for a speech to the nation, where I will explain that the debt ceiling is, in and of itself, unconstitutional.}\quad \text{9} \\
\text{b.} & \quad \text{Now I'm going to explain that this algorithm works whenever } x < 5, \text{ but not when } x \geq 5. 
\end{align*}
\]

- The declarative complements in these examples are answers to the questions in (56a-b), respectively:

\[(56)\]
\[
\begin{align*}
\text{a.} & \quad \text{Is the debt ceiling constitutional?} \\
\text{b.} & \quad \text{When does the algorithm work?}
\end{align*}
\]

- So, in order to check whether *explain* satisfies P-TO-Q DISTRIBUTIVITY, we should verify that (55a-b) entail (57a-b), respectively.

\[(57)\]
\[
\begin{align*}
\text{a.} & \quad \text{Now I'm going to explain whether or not the debt ceiling is constitutional.} \\
\text{b.} & \quad \text{Now I'm going to explain when this algorithm works.}
\end{align*}
\]

- The entailment indeed goes through, which is compatible with the assumption that *explain* satisfies P-TO-Q DISTRIBUTIVITY.

- We leave a more elaborate analysis of *explain*, including an explicit lexical entry, for future work.

\[9\text{http://www.chrisweigant.com/2013/01/11/ftp240/}\]
6.3 Buryat *hanaxa*

- Bondarenko (2019) investigates the clause-embedding predicate *hanaxa* ‘think/recall’ in Buryat, a Mongolic language mostly spoken in Russia along the northern border with Mongolia.

- When combining with a declarative complement, *hanaxa* is non-veridical, as illustrated in (58) (example (4) in Bondarenko 2019).

  (58) dugar miːsɔi zagaha əd-joː gaʒə han-aː xarin miːsgɔi zagaha
  Dugar cat.NOM fish eat-PST COMP think-PST but cat fish
  ədj-ə-ɡųj
  eat-PST-NEG
  ‘Dugar thought that a cat ate fish, but the cat didn’t eat fish.’

- But when combined with an interrogative complement, the predicate is veridical, as illustrated in (59) (example (118) in Bondarenko 2019).

  (59) bi 1SG.NOM badma namxi tata-dag gü gəʒə hana-na-b
  Badma.NOM tobacco smoke-HAB Q COMP think-PRS-1SG
  ‘I am recalling (the true answer to the question) whether Badma smokes.’

- This sentence does not just convey that the speaker recalls *some* answer to the question whether Badma smokes, but that she recalls the *true* answer.

- This means that (60a) can be true without (60b) being true:

  (60)  
  a. Mary *hanaxa* that Bill left.
  b. Mary *hanaxa* whether Bill left.

- Thus, this predicate seems to violate P-TO-Q DISTRIBUTIVITY.

- However, Bondarenko (2019) argues that *hanaxa*, very similar to *explain* according to Elliott *et al.* (2017), combines with declarative and interrogative complements in different ways.

  – Interrogative complements fill an argument slot of the predicate;
  – Declarative complements function as modifications of the event description that the predicate is part of.

- Under this account, the empirical observations made so far are compatible with the assumption that *hanaxa* satisfies P-TO-Q DISTRIBUTIVITY.

- Further empirical work is needed, however, before drawing any firm conclusions. In particular, Bondarenko (2019) only very briefly discusses the behaviour of *hanaxa* when taking an interrogative complement, with (59) as the only example. A more comprehensive investigation would be needed in order to fully understand how the predicate interacts with interrogative complements.
## 7 Conclusion

<table>
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<th>*shknow</th>
<th>*knopinion</th>
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<th>mőtlema</th>
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</table>

(61)
References


Uegaki, W. and Roelofsen, F. (2018). Do modals take propositions or sets of propositions?