Question agnosticism and change of state
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Introduction. A major question in the literature on propositional attitude verbs is why some verbs can take both question (1a) and nonquestion (1b) complements—they are what we term *Q(uestion)-agnostic* verbs—while others can only take nonquestions (2)—they are *Q-rejecting* verbs. (See Hintikka 1975, Karttunen 1977, Groenendijk & Stokhof 1984, Heim 1994 *et seq*).

(1) a. Bo knows whether Jo is happy.   (2) a. *Bo thinks whether Jo is happy.
  b. Bo knows that Jo is happy.   b. Bo thinks that Jo is happy.

As first noted by Hintikka (1975), there is a correlation between a verb's being Q-agnostic and its being factive: a verb is Q-agnostic if it is factive. Starting from this correlation, many approaches have attempted to derive Q-agnosticism from factivity—or more generally, veridicality (Ginzburg 1995, Lahiri 2002, Saebø 2007, Egré 2008, Spector & Egré 2015, Uegaki 2015). As they stand, these approaches do not explain the existence of two classes of Q-agnostic predicates: communicative nonfactive nonveridicals (3) and cognitive nonfactive nonveridicals (4).

(3) a. Bo said that Jo is happy.   (4) a. Bo decided to go to the store.
  b. Bo said whether Jo is happy.   b. Bo decided whether to go to the store.

Recent work suggests that the Q-agnostic communicatives may be derivable as a consequence of their representing discourse objects like Question Under Discussion (Anand & Hacquard 2014), but similar explanations for Q-agnostic cognitive nonfactives have not been proposed.

Proposal. We propose an explanation for the existence of Q-agnostic cognitive nonfactives that captures the following novel generalization: a cognitive nonfactive verb is Q-agnostic if and only if it characterizes a change of state (CoS). (The restriction to verbs is crucial; we believe adjectives fall under a related but distinct generalization that we don't address here.)

   This generalization is exemplified by *decide* and *intend*. The CoS verb *decide* is plausibly the reflexive causative of *intend*. And while *decide* is Q-agnostic (5), *intend* is Q-rejecting (6).

(5) a. Bo decided to eat.   (6) a. Bo intended to eat.
  b. Bo decided whether to eat.   b. *Bo intended whether to eat.

We claim that the CoS semantics of verbs like *decide* licenses Q-agnosticism because their event structure is complex in a particular way; in referencing a change of state, these verbs characterize a relation between an inquisitive pre-state and an informational post-state. In contrast, verbs like *intend* do not license Q-agnosticism because their event structure is simplex; in referencing a state, these verbs select only a question or a proposition. And since they characterize the (informational) post-state of a CoS verb, they furthermore select only a proposition.

Background. To our knowledge, Egré's (2008) is the only account that deals directly with Q-agnostic cognitive nonfactives. Egré defends a slightly modified version of Hintikka's generalization: a predicate is Q-agnostic if and only if it is veridical. He argues that some Q-agnostic predicates only embed questions via a (sometimes silent) preposition. In support, he notes that *decide* can occur with an overt preposition mediating its relationship to an embedded question.

(7) Bo hasn't decided {∅, about, on} whether to plead the fifth.

Egré's account thus explains (some) apparent counterexamples as selectional idiosyncracy. The extension of this strategy to all such apparent counterexamples is problematic if independent evidence of preposition-taking behavior is necessary to posit a silent preposition, since there are cognitive nonfactive nonveridicals that do not take overt prepositions but are Q-agnostic.

(8) a. The fund hasn't determined {∅, *about, *on, ...} whether the stock is valuable.
  b. The fund has determined that the stock is valuable.

Generalization. Indeed, surveying the cognitive nonfactives, there are many Q-agnostic verbs that do not take question-embedding prepositional complements. All of these Q-agnostic verbs are furthermore CoS (9a); and all non-CoS cognitive nonfactive verbs are not Q-agnostic (9b). Thus, given this sample, it appears that if a cognitive nonfactive is Q-agnostic, it is CoS.

(9) a. *CoS cognitive nonfactives:* decide, conclude, determine, judge, estimate, ?opt, resolve, choose, assess, evaluate, appraise, ?elect, rate, prove, deduce, infer, diagnose
      b. *Non-CoS cognitive nonfactives:* *intend, *aim, *aspire, *hope, *want, *prefer, *expect, *suppose, *assume, *believe, *think, *suspect, *suppose

Note. Multiple reviewers suggest the emotive nonfactive *fear* as a counterexample to this generalization. *Worry* could also be cited here. We believe these verbs can be set aside for three reasons. First, in contrast to the verbs in (9a), *fear* and *worry* only allow either WH or polar questions, and this is further complicated by other aspects of the verb's argument structure (11).

(10) a. John {feared, worried} that Mary and Sue might be at the party.
       b. John {???feared, ???worried} which girls might be at the party.
       c. John {???feared, ?worried} whether Mary and Sue might be at the party.

(11) It worried John which girls might be at the party.

Second, even controlling for factivity, emotives are well-known to display constrained question-taking behavior, suggesting that the question-taking behavior of *fear* and *worry* may be governed by a separate generalization involving emotivity. And third, insofar as (10c) is good, it is equivalent to (10a). This mirrors Karttunen's (1977b) observations on the interpretation of *doubt whether*, and it may suggest that *fear* and *worry* never take 'true' polar questions.

Analysis. Previous approaches to Q-agnosticism, focusing on factives, make the plausible assumption that inquisitive and propositional arguments constrain the same part of the lexical semantic structure—e.g., for a verb like *know*, the content of a doxastic state. The relationship between the argument types involves coercion in one or the other direction—e.g., via an ANSWER operator that picks out the true answer to a question (Karttunen 1977a, Heim 1994).

(12) a. Jo doesn't know that Bo danced $\longrightarrow$ Jo doesn't believe that Bo danced.
       b. Jo doesn't know [whether Bo danced]$_Q$ $\longrightarrow$ Jo doesn't believe the true answer to Q.

Note that such a coercion approach doesn't work for nonfactives like *decide* because a 'true' intent (relative to Q) need not exist in the first place; indeed, that is what (13) is used to report.

(13) Jo hasn't decided [whether to dance]$_Q$ $\nrightarrow$ Jo doesn't intend the true answer to Q.

This might be remedied by a choice function analysis (cf. Spector & Egré 2015), but note that under such an analysis, it would remain mystery why *decide* is Q-agnostic but *intend* is not.

  We claim that this CoS verbs like *decide* can't be treated this way because they characterize a complex event that relates an inquisitive pre-state and an informational post-state. When ⟦decide⟧ combines with a question, that question constrains the pre-state content; and when ⟦decide⟧ combines with a proposition, that proposition constrains the post-state content.

  We implement our analysis using a neo-Davidsonian form of George's (2011) Twin Relations Theory. In this theory, Q-agnostic predicates are constructed from two abstract elementary relations $R_\forall$ and $R_\exists$, corresponding to constraints on pre-states $R_\forall = R_{pre}$ (14) and post-states $R_\exists = R_{post}$ (15). These elementary relations form the building blocks of abstract proposition-taking R_{PROP} (16) and question-taking R_{QUES} relations (17) for constructing cognitive CoS verbs.

(14) $R_{pre} \equiv \lambda S.\lambda p.\lambda e.\exists w{:}S(w)(e) \wedge p(w)$ (15) $R_{post} \equiv \lambda S.\lambda p.\lambda e.\forall w{:}S(w)(e) \rightarrow p(w)$

(16) $R_{\text{PROP}} \equiv \lambda S.\lambda p.\lambda e'.\lambda e''.\exists Q : \forall p' : p' \in Q \rightarrow R_{pre}(S)(p')(e') \wedge p \in Q \wedge R_{post}(S)(p)(e'')$

(17) $R_{\text{QUES}} \equiv \lambda S.\lambda Q.\lambda e'.\lambda e''.\forall p' : p' \in Q \rightarrow R_{pre}(S)(p')(e') \wedge \exists p : p \in Q \wedge R_{post}(S)(p)(e'')$

CoS verbs are constructed by supplying one metalanguage predicate that characterizes the pre- and post-states—e.g., INTENTION (18a)—and another metalanguage predicate that characterizes the process by which that change is effected—e.g., DECISION (18b).

(18) a. INTENTION $\equiv \lambda w.\lambda e.w$ is compatible with intensional state e
     b. DECISION $\equiv \lambda e_{pre}.\lambda e_{post}.\lambda e.e$ is a decision with pre-state e_{pre} and post-state e_{post}

(19) a. $[\![\text{intend}]\!] \equiv R_{post}(\text{INTENTION})$
     b. $[\![\text{decide}_{\text{PROP}}]\!] \equiv \lambda p.\lambda e.\exists e', e'' : \text{DECISION}(e')(e'')(e) \wedge R_{\text{PROP}}(\text{INTENTION})(p)(e')(e'')$
     c. $[\![\text{decide}_{\text{QUES}}]\!] \equiv \lambda Q.\lambda e.\exists e', e'' : \text{DECISION}(e')(e'')(e) \wedge R_{\text{QUES}}(\text{INTENTION})(Q)(e')(e'')$

One benefit of using Twin Relations Theory in this context is that its main tenet—that Q-agnosticity arises via a form of regular polysemy—accords nicely with recent experimental/computational findings. Using a large dataset bearing on the syntactic distribution of clause-embedding verbs, in conjunction with a computational model of S(emantic)-selection, White & Rawlins (2016) show evidence that cognitive verbs and communicative verbs instantiate two distinct S-selectional patterns: (i) communicative verbs S-select a unified type for questions and propositions, while (ii) cognitive verbs S-select distinct types for questions and propositions.

This pattern can be captured naturally by assuming (i) a coercion account (Groenendijk & Stokhof 1984, Heim 1994 *et seq*) or an abstract type account (Rawlins 2013, Theiler et al. 2016) for communicative nonfactive nonveridicals (cf. Anand & Hacquard 2014); and (ii) a regular polysemy account, like that given here, for cognitive nonfactive nonverdicals.

Future directions. Many cognitive factive verbs are CoS (e.g., *discover*, *realize*, etc.). Can these verbs be subsumed under our generalization? Our larger project, guided by White & Rawlins's (2016) findings, is to give a general theory of Q-agnosticity that assimilates factives and nonfactives within Twin Relations Theory.

There are two well-known challenges for such a theory. The first is that non-CoS cognitive factives like *know* are Q-agnostic. This means that the theory cannot tie Q-agnositicity too closely to CoS. The second challenge is that CoS is apparently independent of factivity (cf. *find out* vs. *determine*). This means that the theory cannot tie CoS too closely with factivity.

Our suggestion is that Q-agnositicity is really a product of having a particular kind of bipartite lexical semantic structure: one relating two encapsulated eventualities. Being CoS is one way that a verb can come to have that structure. Factivity may be another. One reason this could be is that factives all express relations between entities and facts (cf. Kratzer 1990) as well as some auxiliary relation describing, e.g., the entity's beliefs about the fact (*know*) or how the entity came to be related to the fact (*discover*, *realize*, etc.). This contrasts with a cognitive nonfactive non-CoS, like *intend*, which does not have such a bipartite structure.

Assuming that the existence of two encapsulated eventualities is what gives rise to Q-agnosticism, a question arises regarding which kinds of clausal complements can modify which encapsulated eventuality in such a lexical structure. For instance, all of the verbs in (9a) encode changes from inquisitive pre-states to informational post-states. Is this general to all cognitive CoS verbs or are morphologically simplex verbs meaning, e.g., *undecide* also possible? So far as we can tell, the answer is *no*. If this answer is correct, we aim to further investigate this generalization as a potential constraint on regular polysemy.

Selected references. Anand & Hacquard (2014) *Factivity, belief and discourse* · Egré (2008) *Question-embedding and factivity* · George (2011) *Question Embedding and the Semantics of Answers* · Ginzburg (1995) *Resolving questions* · Groenendijk & Stokhof (1984) *Studies on the Semantics of Questions and the Pragmatics of Answers* · Heim (1994) *Interrogative semantics and Karttunen's semantics for* know. · Hintikka (1975) *Different constructions in terms of the basic epistemological verbs* · Karttunen (1977a) *Syntax and semantics of questions* · Karttunen (1977b) *To doubt whether* · Kratzer (1990) *How specific is a fact?* · Lahiri (2002) *Questions and Answers in Embedded Contexts* · Rawlins (2013) *About* about · Saebø (2007) *A whether forecast* · Spector & Egré (2015) *A uniform semantics for embedded interrogatives: an answer, not necessarily the answer* · Theiler, Roelofsen & Aloni (2016) *A truthful resolution semantics for declarative and interrogative complements* · Uegaki (2015) *Interpreting Questions under Attitudes* · White & Rawlins (2016) *A computational model of S-selection*