Facts, intentions, questions: English 'come-to-know' predicates in deliberative environments

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Abstract

This paper explores a distributional interaction in English between (i) deliberative environments, e.g., *intend*; (ii) 'come-to-know' verbs (CtKs): factive change-of-belief verbs, e.g., *discover* and *find out*; and (iii) complement selection. We show that deliberative environments permit CtKs only when they embed questions. We derive this constraint from a clash between two presuppositions of CtKs, their factivity and change-of-state requirements, that emerges due to the projection properties of deliberative environments. We show that when the factivity presupposition is either absent (as with non-factive change-of-belief predicates) or accommodated locally, CtKs in deliberative environments permit declarative complements.

1 Introduction

This paper investigates patterns of complement selection for 'come-to-know' verbs (CtKs), factive change-of-belief verbs such as *discover*, *find out*, *learn*, *notice*, and *realize* (see Korotkova and Anand 2024 for detailed discussion). All CtKs are responsive predicates (Rawlins and White 2019; Spector and Egré 2015): they take declarative and interrogative complements (1).

(1) Kira **discovered** / **found out** / **learned** {✓that Saturn has 95 moons, ✓which planet has 95 moons}.

However, CtKs are unable to embed declaratives in what we call 'deliberative environments' (following Cariani, M. Kaufmann, and S. Kaufmann 2013; Condoravdi and Lauer 2017). These are enviroments where a rational agent engages in selection of an action plan from a set of options, such as: vanilla attitude verbs of intention (*intend*, *try*), rationale clauses, volitional adverbs (*intentionally)*, desiderative predicates in anakastic conditionals, directive and commissive predicates (*command*, *order*, *promise*, *threaten*), and imperatives. Across these constructions, CtKs are felicitous when they embed an interrogative, but not a declarative:

(2) In his Stanford experiment, Zimbardo **intended** / **tried to discover** / **find out** / **learn** / **verify** {#that/✓how quickly} people conformed to the roles of guard and prisoner.

(3) You call 25 of your friends at random **in order to find out** / **learn** / **discover** / **verify** {#that/✓if} Psarras is the best restaurant in town.

(4) The detective **intentionally found out** / **learned** / **verified** {#that, ✓whether} the actor was sick.

(5) **If you want to find out** / **learn** / **discover** / **verify** {#that, ✓whether} it's humid, you should get a digital barometer.

(6) The doctor commanded their subordinate to **find out** / **learn** / **discover** / **verify** {#that, ✓whether} the patient was well.

This gives rise to the generalization in (7), which we will call DiD for short:

(7) **Declarative-in-Deliberative Prohibition (DiD)**
CtKs in a deliberative environment do not allow a declarative embedding.

Within responsive attitudes, this restriction is true only for CtKs. It does not hold for responsives like *say* (8), stative factives (9), or non-factive change-of-belief predicates such as non-veridical *conclude* or veridical *prove* (10). It is thus difficult to localize DiD to the change-of-state, doxastic, or factive components of CtKs.

(8) Kira **intended** to **say** {✓that Saturn has 95 moons, ✓which planet has 95 moons}.

(9) You need to test this hypothesis **in order to know** {✓that/✓if} the project is viable.

(10) Three criteria need to be met **in order to conclude** / **prove** {✓that/✓if} α causes β.

Furthermore, DiD is restricted to deliberative environments. Other future-oriented environments, including bouletic predicates (when not used deliberatively), admit CTKs with declaratives (11).

(11) Odo **hopes** / **wishes** / **is afraid** / **expects** to **learn** {✓that/✓if} there is life on Mars.

To sum up, declarative embedding is disallowed precisely when the embedder is a coming-to-know predicate in a deliberative environment. We argue that this restriction arises because of a conflict of two presuppositions that CtKs trigger: (i) the factivity of their declarative complements and (ii) a lack of belief in the prejacent by CtK experiencer prior to the change-of-doxastic-state. When these project across deliberative environments, they produce a clash. For reasons of space, we focus on intention verbs below, and assume that other deliberative environments behave the same way in aspects relevant to us.

2 Proposal

Coming-to-know eventualities involve belief change and knowledge. A deliberative agent does not have complete control over whether someone's beliefs will change or whether those beliefs are accurate. It is thus tempting to pin DiD on this lack of complete control, since deliberative predicates like *try* are known to be infelicitous with complements denoting eventualities the agent cannot control (e.g., the oddity of *?I tried to accidentally stumble*). But the data above shows things are not straightforward: we cannot categorically ban CtKs in deliberative environments, since they are acceptable when they embed interrogatives. Nor can we say containing doxastic change renders a predicate insufficiently controllable, since coming-to-believe predicates with declaratives are acceptable in deliberative environments.

It is instructive here to consider Jenkins (2019), who aims at providing a new theory of *try* and along the way puts forth the only discussion of something like DiD we are aware of. Capitalizing on previous work, Jenkins uses two cases of infelicity with doxastic change-of-state predicates to motivate his proposal:

(12) a. #Mary tried to realize that the oven was on. (Jenkins 2019)
b. #Mary tried to notice a picture. (Sharvit 2003)

Jenkins' semantics for *try* is couched in terms of expected utility (EU) of the prejacent ϕ. It assumes (i) a decision model that provides a subjective probability measure Pr_α over the set of doxastic alternatives A for deliberative agent α; and (ii) a set of possible actions, or choices $\mathcal{C} = \{\Delta_1, \ldots \Delta_n\}$ for α. Relative to these, α *try* ϕ is true only if α selects some Δ from $\mathcal{C}$ that increases the chances of bringing the prejacent about $Pr_\alpha(\phi|\Delta) > Pr_\alpha(\phi|\neg\Delta)$. In his discussion of the cases in (12), Jenkins assumes that *notice an x* is equivalent to *come to believe there is an x*, treating DP complements on a par with declaratives. He proposes that the oddity of these

cases arises because both Pr_{Mary} and the prejacents in (12) are defined over Mary's doxastic alternatives. His argument is then that no Δ could increase the probability of coming-to-believe the prejacent because A would have to already validate the prejacent.

Jenkins' discussion is phrased entirely in terms of belief, and so it directly predicts that come-to-believe predicates embedding declaratives should likewise be infelicitous in deliberative environments, contrary to the felicity we observed in (10) for *conclude* and *prove*. Nor does his account explain the felicity of CtKs with interrogatives (which he does not discuss).[1] However, we believe that Jenkins' underlying intuition is correct, once we see it as a product of factivity: the reason one cannot *try to figure out that p* is because, as a factive, *figure out* will project into the deliberative agent's doxastic state the requirement that p holds. And this, in turn, will clash with a change-of-doxastic-state requirement that *figure out* possesses. We turn to each of these requirements next.

2.1 CtK requirements: Factivity and lack of prior belief

CtKs are poster child cognitive factives (Degen and Tonhauser 2022; Djärv 2019; Karttunen 2016). Here, we will assume that they presuppose that their declarative complements are true in the evaluation world (13), a condition we gloss as Factivity:

(13) **Factivity**:
$CtK(x, p, t, w)$ is defined only if $p(w) = 1$.

Unlike stative factives, CtKs encode belief formation, a transition from not having a belief that p (unsettledness about p or belief in $\neg p$) to having it (Korotkova and Anand 2024; Rawlins and White 2019), akin to conditions for change-of-state verbs at large (Karttunen 1973).

(14) **Lack of Belief**:
$CtK(x, p, t, w)$ is defined iff $\forall t' < t[\neg \textsc{believe}(x, p, t', w) = 1]$,
where $\textsc{believe}(x, p, t, w) = 1$ iff $\forall w'' \in DOX(x, t, w)[p(w'') = 1]$.

CtKs are thus incompatible with a prior belief that p (15):

(15) # The children were sure that I was asleep, and then learned from their mother that I was asleep.

2.2 Presupposition projection in deliberative environments

Deliberative environments, like bouletics, invoke preferences. But they also share properties with doxastics. First, they require **realism**, the condition that the prejacent be epistemically possible for the deliberative agent, preventing an intention to do something impossible. Second, they demand **consistency** among the commitments of the deliberative agent, preventing commitment to incompatible propositions (Condoravdi and Lauer 2016; Grano 2017; Grano 2023; Grosz 2014; Hansson 2001):

(16) a. I {#intend, ✓want} to be a robot. REALISM
b. J. intends to move in w/ his girlfriend, #but also intends to keep living alone. (Condoravdi and Lauer 2016) CONSISTENCY

[1] In fact, unlike other CTKs, *notice* and *realize* are never acceptable in deliberative environments regardless of the complement shape (Korotkova and Anand 2024), cf. *#Mary tried to notice/realize whether the oven was on.* These verbs (but not CTKs at large) describe non-controllable actions and therefore are banned in deliberative environments altogether independetly of DiD.

Realism in turn yields a presupposition projection pattern for deliberative environments distinct from that of preference-oriented attitudes like bouletics (cf. Grano 2017; Sharvit 2003). In particular, like doxastics, it requires that the deliberative agent's doxastic state universally satisfies the presuppositions of the complement clause, as can be observed with the existence presupposition triggered by a possessive definite:

(17) Neo, unknowingly a brain in a vat, **planned** to raise **his arm**, #but believed he had none. (adapted from Grano 2017)

For our purposes, the descriptive characterization of this projection pattern in (18) is sufficient:

(18) **Deliberation Projection**:
If p presupposes q, $\textsc{intend}(x, p, t, w)$ is defined only if $\textsc{believe}(x, q, t, w)$.

2.3 Deriving DiD

The crux of our analysis is that when a declarative-embedding CtK is inside a deliberative environment, Deliberation Projection pits Factivity against Lack of Belief. Ordinarily, the two do not interact: Factivity references the evaluation world w and Lack of Belief references the deliberative agent's doxastic state in w at t. But when a CtK is within a deliberative environment, Deliberation Projection means that Factivity becomes a constraint of the deliberative agent's doxastic state, and this yields a temporal contradiction: (a) Factivity requires the deliberative agent to believe the CtK complement at deliberation time, (b) Lack of Belief requires no belief at deliberation time. Thus, like for Jenkins, this proposal involves a clash between belief in p and a lack of belief in p, but it is crucially mediated by factivity. Correspondingly, non-factive attitudes, including come-to-believe ones, correctly allow declarative complements in deliberative environments. So, too, do CtKs when they embed interrogatives: as we show in Section 3, no particular proposition projects into the deliberative agent's doxastic state, and hence nothing clashes with Lack of Belief. In what follows, we make several choices in order to provide a concrete proposal, but our account is compatible with many existing theories of deliberative environments and various approaches to responsive predicates and question embedding.

Deliberative attitudes involve selecting a course of action. This can be cashed out through filtering by a decision problem ordering (Cariani, M. Kaufmann, and S. Kaufmann 2013), an effective preference pre-order (Condoravdi and Lauer 2016), ordering by continuation branches of an initial event-stage (Sharvit 2003), continuation of an event-stage in intention worlds (Grano 2017), and computation of expected utility (Jenkins 2019). For simplicity, we will assume that *intend* quantifies over $INT(x, t, w)$, optimal worlds drawn from $DOX(x, t, w)$ and ordered by propositions representing the intentions linked to the deliberative event, predicating of those worlds that the complement property is true at some interval t'' after intention time t.

(19) $\textsc{intend}(x, P, t, w) = 1$ iff $\forall w' \in INT(x, t, w)\ \exists t'' > t\ [P(t'')(w') = 1]$

Consider now (20), where *intend* embeds the subject-controlled CtK *learn*; each $w'' \in INT$ thus has a future t'' where Kira learns p.

(20) #[Kira intends [to learn [that Saturn has 95 moons]]].
$\textsc{intend}(\text{Kira},\ \lambda t' \lambda w' \textsc{learn}(\text{Kira}, p, t', w'),\ t, w) = 1$
iff $\forall w'' \in INT(\text{Kira}, t, w)\ \exists t'' > t\ [\textsc{learn}(\text{Kira}, p, t'', w'') = 1]$

a. projected Lack of Belief:
$\forall w'' \in DOX(\text{Kira}, t, w)\ \exists t'' > t\ \forall t''' < t''\ [\neg \textsc{believe}(\text{Kira}, p, t''', w'') = 1]$

b. projected Factivity:
$\forall w'' \in DOX(\text{Kira}, t, w)\ p(w'') = 1$, or $\textsc{believe}(\text{Kira}, p, t, w) = 1$

Lack of Belief requires that prior to t'', Kira does not believe p, and by Deliberation Projection, this projects as a general belief by Kira about her own lack of belief stretching to variable points in her future (20a). Factivity projects to the requirement that Kira believes p at intention time t (20b). This is a temporal contradiction: it cannot be the case that Kira believes p at t and that, relative to a t'' after t, Kira never believed p.

The contradiction crucially only arises because of Deliberation Projection, which forces Factivity to project universally over all of $DOX(x, t, w)$, ensuring that x believes p at t. Were the factivity requirement to project to the INT worlds (or accommodate to them), we would merely require that the most ideal worlds are ones where the learned proposition were true. As this would only be a requirement for the ideal worlds, it would not require Kira's doxastic state at t to be settled on p, allowing Lack of Belief to be satisfied. We suggest this is precisely what occurs when CtKs occur in bouletic environments like those in (11), where Odo's optimal bouletic worlds are ones where there is life on Mars and he comes to know that fact. Thus, while desiderative predicates are known to disprefer local accommodation (Heim 1992), they allow it, enabling the embedding of a CtK without running afoul of Lack of Belief.

Our account relies on the identity between the deliberative agent and the CtK believer (so that Lack of Belief and Factivity target the same individual's doxastic state). We thus correctly predict that distinct subjects will not be subject to DiD (21):

(21) The teacher intended for the students to learn that Saturn has 95 moons.

We also predict felicity in cases where agent is the believer but (i) read non-*de se* or (ii) where there is a lack of continuity of the doxastic state. Thus, for example, if the deliberative agent is knowingly forgetful, and is planning to overcome their own later forgetting of a fact, DiD should not hold (we are grateful to an anonymous referee for pointing out these cases). Such scenarios may be quite unlikely, but we are here inspired by the Christopher Nolan film *Memento*, in which an investigator with anterograde amnesia uses messages written to his later self to overcome the inevitable forgetting. In such a situation, declarative embedding CtKs are acceptable:

(22) *A detective suffering from anterograde amnesia permanently forgets new information about a case upon waking the next morning.*
The detective wrote "don't trust him" on a Polaroid of a man in order to later (re)discover that the man is working against him.

3 Intermediate accommodation and question embedding

Our account for DiD relies on a clash of projected Factivity and Lack of Belief, and predicts that infelicity will not arise in at least two cases. The first case is when the predicate downstairs is not factive (hence nothing contradicts Lack of Belief). This is precisely what happens with come-to-believe predicates as in (10). The felicity of veridical predicates like *prove* indicates that it is not the truth of p *per se* that matters, but truth throughout the doxastic state, which we argues arises due to the interaction of factivity and Deliberation Projection.

Our second case is when the predicate is factive but the factive presupposition is accommodated before it can project via Deliberation Projection. We argue now that this is what occurs when CtKs embed interrogatives. While CtKs are factive when they embed declaratives, like other factive responsives, when they embed interrogatives, the resulting structure does not project a factive presupposition. In what follows, we will appeal to the system in Spector and Egré (2015) For concreteness (though our account can be couched in inquisitive approaches to responsive predicates). This system assumes that declaratives denote propositions and interrogatives denote sets of propositional answers. Responsive predicates take propositional complements, which means to that they cannot combine directly with interrogatives. Instead, an existential

quantifier ranging over elements in the interrogative is introduced, and the responsive takes this existentially bound element as its propositional argument, as schematized in (23):

(23) $\text{CtK}(x, Q, t, w) \leftrightarrow \exists p \in Q\ \text{CtK}(x, p, t, w)$

CtKs trigger Factivity, but the factive presupposition projects into the existential's domain:

(24) ✓[Kira intends [to learn [if Saturn has 95 moons]]].
$\textsc{intend}(\text{Kira},\ \lambda t'\lambda w'\textsc{learn}(\text{Kira}, Q, t', w'),\ t, w) = 1$ iff $\forall w'' \in INT(\text{Kira}, t, w)$
$\exists t'' > t\ \exists p \in Q$ [**p(w")=1** $\wedge\ \textsc{learn}(\text{Kira}, p, t'', w'') = 1$].

The factivity thus does not project further, and hence is not subject to Deliberation Projection, which means there is no presupposition that Kira believes any p. We thus have that relative to the ideal worlds in INT: (i) some answer $p \in Q$ is the case; (ii) at some future t'', Kira believes p is true; and (iii) that prior to t'', Kira does not believe p. Because we are restricting ourselves to Kira's ideal worlds here, there is no contradiction, so we correctly predict that CtKs with interrogative complements are felicitous in deliberative environments.

Nothing in this explanation is unique to question-embedding, and we thus predict that CtKs with declarative complements should be felicitous if other operators intervene between the CtK and the intention predicate, preventing Deliberation Projection from interacting with factivity. This is indeed the case—epistemic modals (25), negation (26) and coordination (27) all serve to rescue declarative-embedding CtKs:

(25) The student **intended** to **possibly** learn from the video that there were other ways to solve the problem.

(26) By deleting his email, the patron **intended** to **never** discover that his library books were overdue.

(27) The gambler **intended** to win the lottery **and** learn that he had won.

Under our account, this is expected, since such operators, like interrogative embedding, create a space for accommodation that blocks the application of Deliberation Projection, and the generation of a presupposition of belief by the deliberative agent that clashes with Lack of Belief.

4 Conclusion

Deliberative environments have received heavy scrutiny over the past two decades, with much attention to how controllability, agentivity, and action-guidance can inform the restrictions on the prejacents of such environments. Focusing on the behavior of factive change-of-state predicates, we have argued that presuppositional content is also a factor in explaining these restrictions, in line with Theiler, Reolofsen, and Aloni (2019) on the role of presuppositions in complement selection. We have shown that deliberative environments interact with presupposed content in a manner distinct from bouletics, but we have not here rigorously derived the source of that distinct behavior. All deliberative environments require choice from a set of actions, and we believe it is this focus on circumstantially accessible actions that scrupulously enforces that all presuppositions are satisfied by the doxastic state. We hope—and indeed intend—to more fully develop this tentative proposal in the future.

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