Adjacency Pairs in Common Ground Update: Assertions, Questions, Greetings, Offers, Commands

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Abstract

Dynamic theories of communication focus on the update of the common ground by individual speech acts; for Conversation Analysis, the way that the individual contributions interlock, forming adjacency pairs, are an essential object of study and theorizing. The article proposes a way to enrich dynamic theories by taking into account the possible continuations of speech acts. It focuses on assertions and questions, and extends the treatment to other speech acts.

1 Introduction

Human language communication has been studied from different angles, resulting in quite divergent views that sometimes appear downright incompatible. For instance, on the one hand there are prominent approaches originating in language philosophy, in particular **Speech Act Theory** (Austin 1962, Searle 1969) and the notion of information transfer as **update of Common Ground** (CG) (cf. Stalnaker 1978, 2002). They were successful in describing isolated phenomena, often identified in constructed examples, such as indirect speech acts (Searle 1975), anaphora (Kamp 1981) and projecttion of presupposition (Heim 1983). On the other hand, there are prominent empirically-driven approaches that pay close attention to actual communicative exchanges, as in **Conversation Analysis** (Sacks et al. 1973, Levinson 2013). They studied phenomena like turn taking that regulate the exchange, the use of backchanneling devices to ensure mutual understanding, and, if that failed, the employment of repair strategies.

A frequent complaint about the first family of approaches is that they put their main focus on the description of single communicative acts, and thus are unable to grasp the dynamics of conversation, where actors plan and shape the direction the conversation should be taking (cf. Levinson 1981, 2017). Approaches of the second type appear far removed from explaining how meaning assignment to complex expressions works and how different aspects of meaning, such as presuppositions, implicatures and alternatives, are woven together. Both approaches exhibit successes, but also have their blind spots. Whether they can be fruitfully combined is an open issue for the authors of Searle et al. (1992). But there are in fact attempts to do so, such as Clark (1996) and Ginzburg (2012), who explicitly combine conversation analysis and CG update.

The current paper presents an **algebraic model of CG update** that is closer to classical speech act theory and accommodates the **sequencing of speech acts** that we observe in communication, thus integrating insights of both research traditions and resulting in a model of communication that takes its interactive nature seriously.

2 Adjacency Pairs

Conversation Analysis offers the notion of **adjacency pairs** as a basic theoretical term to describe the organization of discourse (Schegloff & Sacks 1973). These are conversational moves by one participant, the “first pair part” (FPP), that require corresponding moves of a particular type by the other participant, the “second pair part” (SPP). Examples are greeting-greeting back, question-answer, request-grant (or refusal), proposal-acceptance (or declining). Assertion-confirmation (or rejection), even though not considered adjacency pairs because assertions are said not to require a response, can be seen in similar ways. In case the FPP is not followed by a corresponding SPP, the sequence is felt incomplete, and quite often the initial action will be repeated to achieve success. There are various ways to elaborate on the basic pattern of adjacency pairs by pre-, insert- and post-expansions. Adjacency pairs take on a central role

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in the textbook by Schegloff (2007), which is evidence for their usefulness for the empirical analysis of conversation.

Early approaches to **sequencing of speech acts** like Kendziorra (1976), Wunderlich (1979) and Ferrara (1980) were not taken up broadly. Searle (1992) considered adjacency pairs to be the most promising aspect of Conversation Analysis to enrich Speech Act theory, but still was skeptical, among other reasons because of the wide variety of appropriate response reactions to a given act.

Speech act theory developed the notion of **felicity conditions** that can be used to specify the **preconditions** that have to be met for a speech act, which often involves the existence of preceding acts. For example, it is a precondition for an answer that a corresponding question was asked. However, preconditions were used in a much wider sense, e.g. for directives, that the addressee is able to carry out the action specified by the directive speech act. For adjacency pairs one would rather need a notion of "postconditions" for speech acts, i.e. how a particular type of speech act is taken up in discourse. By their design, felicity conditions are not suited to capture this forward-looking aspect of speech acts.

Models of **dynamic CG update** did not originally incorporate a notion of interacting conversational moves either, even though such considerations were present in the early work of Hamblin (1971). However, there are more recent approaches that try to represent the dynamics of questions vs. answers, and of assertions vs. (dis)agreements. In particular, the notion of Questions under Discussion provides a tool for modelling this dynamics (cf. Roberts 1996, 2018; Onea 2019). Furthermore, Farkas & Bruce (2010) developed a model that features a negotiation table for updates. Inquisitive Semantics (Ciardelli et al. 2019) provides a CG model for updates with assertions and questions. Also, SDRT (cf. Lascarides & Asher 2009, Hunter et al. 2018) models the intertwining of linguistic discourse and actions, and Murray & Starr (2021) propose a CG model for updates with evidentially modified assertions, commands, and other speech acts.

In this paper I will make use of **Commitment Spaces** (Cohen & Krifka 2014), as this model appears particularly well-suited for dealing with adjacency pairs; its major design feature is the integration of continuations into the notion of CG. Also, it is a rather straightforward extension of the original CG update approach by Stalnaker. Furthermore, it provides an algebraic structure for discourse moves with well-known operations like conjunction, disjunction and denegation.

3 Commitment Spaces

The framework of Commitment Spaces has been developed for pairs of assertions and confirmations or rejections, and for pairs of questions and answers (cf. Krifka 2015, 2022). This article will improve the treatment of assertions and questions, and investigate the potential of the CS framework for modeling adjacency pairs in general.

The CS model starts out with **Commitment States** (**CSts**), which are modeled by non-empty sets of propositions that represent the information about the world and time at which the conversation takes place – more specifically the information that the interlocutors assume to be shared. This contains information about the individual commitments of the participants. If c is such a set of propositions, its conjunction $\bigcap c$ is a set of world-time indices, the "context set" in the sense of Stalnaker (1978). The propositions in a CSts should be consistent (non-contradictory), and also satisfy certain additional **integrity constraints**, some of which we will discuss below.

The notion of **Commitment Spaces** (**CSs**) captures not only information that is shared but in addition the mutual understanding of ways how this shared information can develop in conversation. Hence, a CS is a set of CSts. Disregarding the distinction between informative and performative update (cf. Szabolcsi 1982), **update of a CSt** c with a proposition φ (a function from world-time indices to truth values) restricts c to those indices in which φ is true, cf. (1).

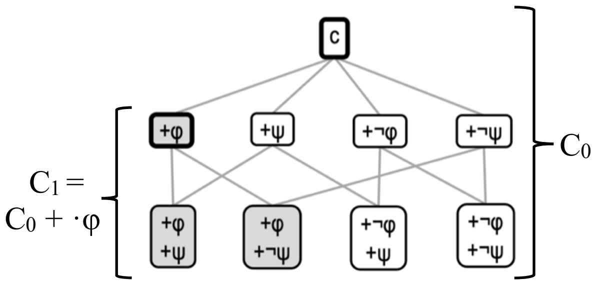
1. $c+\varphi = c \cup \{\varphi\}$, if the integrity constraints for CSts are satisfied, else undefined.

Update of a CS C with a proposition φ restricts C to those CSts c in which φ holds, cf. (2). Here, "·" is an operator that turns a proposition into the corresponding CS update function.

2. $\cdot\varphi(C) = \{c \in C \mid \varphi \in c\}$, also $C + \cdot\varphi$

For example, in (3) a CS consisting of a minimal CSt c and updates by the four propositions φ, ψ. ¬φ and ¬ψ gets updated by φ, resulting in the gray CS.

3. Example: Update of CS C_0 by $\cdot\varphi$



The view of communication as adding information to a CSt is replaced by weeding out those CSts that do not fit to the information that is communicated.

The bold CSt represents the **root** of the CS, the most general CSt that stands for the information accrued so far in the CG; the continuations stand for the ways how the CG can develop. The root of a CS is defined as the set of least informative CSts:

4. $\surd C = \{c \in C \mid \neg\exists c'[c' \in C \wedge c' \subset c]\}$

For example, we have $\surd C_0 = \{c\}$ and $\surd C_1 = \{c+\varphi\}$. Ideally, the root is a singleton, but situations with multiple roots may arise when it is unclear what the shared information actually is. Such multiple roots can be used to model open issues that still have to be resolved, similar to questions under discussion (cf. Kamali & Krifka 2020).

CS updates can be **combined** in various ways. Let A and B be CS updates, then conjunction, disjunction and denegation are defined as follows:

5. $[A \& B](C) = A(C) \cap B(C)$ conjunction

6. $[A \vee B](C) = A(C) \cup B(C)$ disjunction

7. $[\sim A](C) = C - [A](C)$ denegation

We also have dynamic conjunction (composition) and an operator ? that retains the root of the input CS but restricts the continuations:

8. $[A;B](C) = B(A(C))$ dynamic conjunction

9. $[?A](C) = \surd C \cup A(C)$ restriction

The following examples illustrate these notions with respect to the CS C_0 in (3).

10. $[\cdot\varphi \,\&\, \cdot\psi](C_0) = \{c+\varphi+\psi\} = \{c+\psi+\varphi\}$

11. $[\cdot\varphi \vee \cdot\psi](C_0) = \{c+\varphi, c+\psi, c+\varphi+\psi, c+\varphi+\neg\psi, c+\psi+\neg\varphi\}$

12. $[\sim\cdot\varphi](C_0) = \{c, c+\psi, c+\neg\varphi, c+\neg\psi, c+\neg\varphi+\psi, c+\neg\varphi+\neg\psi\}$

13. $[\cdot\varphi \,;\, \cdot\psi](C_0) = \{c+\varphi+\psi\}$

14. $[?\cdot\varphi](C_0) = \{c, c+\varphi, c+\varphi+\psi, c+\varphi+\neg\psi\}$

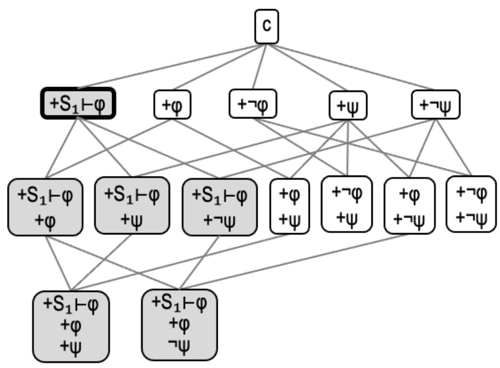
Conjunction (10) and **dynamic conjunction** (13) lead to the same result but achieve this in distinct ways. They differ for anaphoric bindings, as in a dynamic conjunction antecedents in A could bind anaphors in B. **Disjunction** (11) leads to continuations in which either disjuncts are established, which often leads to multiple roots. For example, the root of $[\cdot\varphi \vee \cdot\psi](C_0)$ is $\{c+\varphi, c+\psi\}$. **Denegation** (12) removes the possibility that an update occurs, which can be used to model speech acts like *I don't promise to come* (cf. Cohen & Krifka 2014). It typically leaves the root intact, for example the root of $[\sim\cdot\varphi](C_0)$ is $\{c\}$. **Restriction** (14) is like update but retains the CSts in the root, here c.

These are the features of the CS framework in its most basic form. We now set them to work by looking at a model for assertions.

4 Assertions

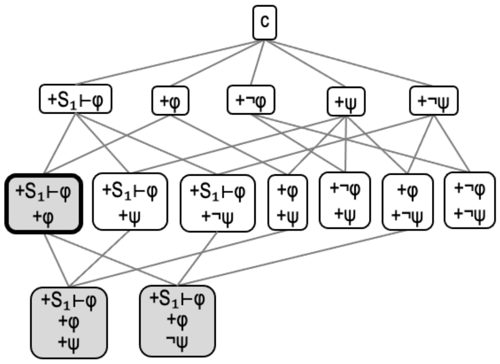
Assertions are not just updates by propositions enforced by a speaker. Rather, the speaker must provide reasons for the addressee to adopt the proposition (cf. Lauer 2013). There is a growing consensus that speakers achieve this by a particular **commitment**, namely by **vouching for the truth of the proposition** (cf. Shapiro 2020; the view can be traced back to Charles S. Peirce, cf. Tuzet 2006; cf. also Brandom 1994). Writing "$S_1 \vdash \varphi$" for the proposition $\lambda i[S_1$ vouches in i that φ is true in i], Krifka (2015) proposes that the characteristic **illocutionary act of assertion** of a proposition φ consists in the speaker S_1 updating the CS by the public commitment of S_1 to the truth of that proposition, i.e., by the proposition $S_1 \vdash \varphi$, with respect to the time of the utterance. This is illustrated in (15):

15. Illocutionary act: $C_2 + \cdot S_1 \vdash \varphi = C_3$



With this backing, the speaker attempts to update the resulting CS by φ itself. This is the intended effect of assertions, their **primary perlocutionary act**: The speaker wants to communicate φ, which is modeled by having it accepted in the CS.

16. Primary perlocutionary act: $C_3 + \cdot\varphi$



5 Accommodating for Reactions

The addressee S_2 has a say in this second move. S_2 can react with *yes* and **confirm** it by also committing to φ, updating with $S_2\vdash\varphi$; or S_2 can say *okay* or **accept** it in other ways, including by not objecting. But S_2 can say *no* and **reject** it by committing to ¬φ, $S_2\vdash\neg\varphi$. It is reasonable to assume an integrity constraint that no CSt c allows for both the propositions φ and $S\vdash\neg\varphi$ be true if S is a participant in conversation. Hence a CS cannot even be updated by $S_2\vdash\neg\varphi$ once φ has been established. The acceptance of φ has to be negotiated – but how should this be modeled?

There are different formal accounts for negotiation in CG update models. For example, Merin (1994) proposes a finite-state automaton representing an "algebra of elementary social acts" that may run in a loop until one of the participants concedes. In their "table" model, Farkas & Bruce (2010) propose that no record of S_1's initial move is kept if S_2 does not accept it. Krifka (2015) assumes an additional structure, CS developments, allowing for retraction of the most recent move; in case S_2 rejects the attempt of S_1 to assert φ, by saying *no*, the CS will retain the propositions $S_1\vdash\varphi$ and $S_2\vdash\neg\varphi$, hence keep the information that S_1 and S_2 disagree about φ, but not the proposition φ itself.

This article uses the forward-looking feature of CSs, the continuations, to model the effect of rejection without any additional machinery. The overall approach is this: In an assertion, the speaker S_1 first updates the CS with the commitment that the asserted proposition φ is true, rendered as $S_1\vdash\varphi$. This is the illocutionary part. S_1 offers the addressee S_2 not one, but **two continuations**: Either **update with the proposition** φ itself (the intended perlocutionary effect), or a continuation in which S_2 voices **disagreement against update** with φ. I will model the second update by the proposition 'S_2 announces doubts concerning φ', rendered as $S_2\dashv\varphi$, which is incompatible with φ and also with $S_2\vdash\varphi$ by integrity constraints. We assume that the propositions $S_2\dashv\varphi$ and $S_2\dashv\neg\varphi$ can obtain simultaneously in a CSt, they are not ruled out by integrity constraints, different from $S_2\vdash\varphi$ and $S_2\vdash\neg\varphi$. This leads to the following analysis of assertions:

17. Speaker S_1 asserts φ at C_4:
$C_4 + [\cdot S_1\vdash\varphi\ ;\ [\cdot\varphi \vee S_2\dashv\varphi]] = C_5$

This is a dynamic conjunction of an update with the commitment of S_1 to the proposition φ, followed by a disjunction that allows for either the continuation φ or the continuation that S_2 doubts φ. If C_4 is mono-rooted with c_4 as its single CSt, C_5 has a two-element root: $\{c_4 + S_1\vdash\varphi + \varphi,\ c_4 + S_1\vdash\varphi + S_2\dashv\varphi\}$.

Let us consider the possible reactions of S_2 to this disjunction. First, S_2 may **confirm** φ by saying *yes*, updating the CS by $S_2\vdash\varphi$ (where *yes* contains an anaphoric reference to propositions, cf. Krifka 2013). This excludes the disjunct $S_2\dashv\varphi$ due to the integrity constraint mentioned above. The proposition φ is established, and S_2 vouches for it as well:

18. $C_5 + \cdot S_2\vdash\varphi = C_4 + \cdot S_1\vdash\varphi + \cdot\varphi + \cdot S_2\vdash\varphi$

Second, S_2 may just say *okay* and **assent** to φ. This can be interpreted as denegation of $S_2\vdash\neg\varphi$: S_2 indicates non-objection. Under a general rule that objections should be raised as soon as possible (Walker 1996, Faller 2019), even lack of action can be interpreted in this way. Now, the update with $\sim\cdot S_2\vdash\neg\varphi$ is compatible with a CS at which φ is established, but not with a CS at which $S_2\dashv\varphi$ is established. We can assume a plausible integrity constraint for CSs stating that whenever $S_2\dashv\varphi$ is established there must be continuations at which $S_2\vdash\neg\varphi$ gets established – whoever expresses doubt on a proposition might become committed to its negation. Hence update with *okay*, $\sim\cdot S_2\vdash\neg\varphi$, is compatible only with the first disjunct of (17), leading to the establishment of φ:

19. $C_5 + [\sim\cdot S_2\vdash\neg\varphi] = C_4 + \cdot S_1\vdash\varphi + \cdot\varphi$

We did not model the opt-out disjunct in (17) by "weak rejection" of Incurvati & Schlöder (2017), which amounts to $\neg S_2 \vdash \varphi$, the announcement of non-commitment to φ, as we want to allow for the case of assent, where a proposition φ is in the CG even though not all participants vouch for its truth. The announcement of doubt $S_2 \dashv \varphi$ can be seen as requiring that $S_2 \vdash \neg\varphi$ holds in some continuation.

Third, S_2 may express **dissent** by saying *no*, updating the CS by $S \vdash \neg\varphi$. As this update is not compatible with $\cdot\varphi$ due to an integrity constraint, now the first disjunct of (17) is excluded, resulting in (20). This is a coherent CS in which it is established that S_1 and S_2 do not agree on φ:

20. $C_5 + \cdot S_2 \vdash \varphi = C_4 + \cdot S_1 \vdash \varphi + \cdot S_2 \vdash \neg\varphi = C_6$

What these three reactions have in common is that they **reduce the root** of the CS that was increased by the disjunction in in (17). Multiple roots stand for issues that are still undecided; reducing them not only increases the overall information in a CS but also removes that uncertainty in its root (cf. Kamali & Krifka 2020).

Consent and dissent need not be performed with speech acts involving the very proposition φ or ¬φ. Other assertions that have a bearing on φ or ¬φ, like S_1: *It is raining.* S_2: *I think so too / I don't think so*, can be seen as confirming or expressing doubt or dissent as well. This can be dealt with by integrity constraints that rule out, e.g, that both φ and 'x believes ¬φ' ($B_x \neg\varphi$) are part of a CSt, if x is a participant of conversation. For example, update by *I don't think so* results in (21). Here, S_2 commits to $S_2 \vdash B_{S_2} \neg\varphi$ (assuming neg raising), attempting to put $B_{S_2} \neg\varphi$ into the CS (the second disjunct that S_1 doubts this proposition is rather hypothetical as S_1 is not an epistemic authority over S_2's beliefs).

21. $C_5 + [\cdot S_2 \vdash B_{S_2} \neg\varphi \,;\, [\cdot B_{S_2} \neg\varphi \vee \cdot S_1 \dashv B_{S_2} \neg\varphi]]$
$= C_4 + \cdot S_1 \vdash \varphi + \cdot S_2 \dashv \varphi + S_2 \vdash B_{S_2} \neg\varphi$

The update is only compatible with the second disjunct in (17), denegating the commitment of S_2 to φ. In addition, the proposition that S_2 commits to not believing ¬φ is introduced, as well as the proposition that S_2 does not believe ¬φ.

Other reactions to assertions of a proposition φ can express doubts by asserting a proposition ψ that make φ less probable, such as S_1: *It will rain.* S_2: *But the report said it will be fine.* Such assertions of ψ are compatible with both φ, the proposition that S_1 intends to introduce, and $S_2 \dashv \varphi$, that S_2 expresses doubts about φ. Hence they do not decide the issue but leave it open to additional arguments.

In summary, the representation of assertions developed here incorporates **adjacency pairs** into a model of CS change by offering certain continuations after the illocutionary update $S_1 \vdash \varphi$: either φ gets established (by confirming or by assenting, i.e. refraining from dissenting), or $S_2 \dashv \varphi$ gets established (by dissenting). The FPP (17) allows for SPPs like *yes*, *okay* or *no*, but also for other moves that favor one continuation over the other.

6 Retracting Commitments

If conversation leads to a CS that contains both $S_1 \vdash \varphi$ and $S_2 \vdash \neg\varphi$, then neither φ nor ¬φ can be established in the future development of the CS. Either speaker can repeat his or her claims, but this will not move the conversation forwards (cf. Merin 1994). In real life, there are ways out of such quandaries: We can agree to disagree and live with the contradictory claim and turn to other tasks or topics, or one speaker can give up his or her claim. How can this be modeled? We need an account for what happens when speakers **retract** their commitments.

As CSts are modeled as sets of propositions, we can capture such operations as removing a proposition from the CSts of a CS:

22. $C + {}^{-}\varphi = \{c - \{\varphi\} \mid c \in C\}$ retraction

Retraction is a peculiar move. The updates we considered so far restrict the CS they apply to; for such updates A we have $A(C) \subseteq C$. In contrast, retraction is **non-monotonic**: Updating C_1 in (3) by $-\varphi$ results in $\{c+\psi, c+\neg\psi\}$, which is not a subset of C_1. Furthermore, the CS may contain propositions that entail the retracted proposition, which then also would have to be removed.

There is also a move of **addition** of a proposition φ to a CS C that was previously ruled out:

23. $C + {}^{+}\varphi = \{c \cup \{\varphi\} \mid c \in C\}$ addition

The resulting CSts must satisfy the integrity constraints. Such operations require modeling as belief revisions (Gärdenfors 2003), where retraction corresponds to **contraction**, and there is an operation of **revision** $[C + {}^{-}\neg\varphi] + {}^{+}\varphi$ for consistent addition.

Participants are not entitled to remove just any proposition from a CS. But it should be admissible that speakers remove their own commitments or doubts; e.g. S_1 can remove $S_1 \vdash \varphi$ or $S_1 \dashv \varphi$. Even this comes with social costs, as normally people are supposed to stick to their commitments. However, removing one's commitments should incur higher costs than removing one's doubts.

The communicative impasse in our example can be dissolved by either S_1 giving up $S_1 \vdash \varphi$, as illustrated in (24) for the CS of (20), or alternatively by S_2 giving up $S_2 \vdash \neg\varphi$.

24. $C_6 + {}^{-}S_1 \vdash \varphi = C_4 + \cdot S_2 \vdash \neg\varphi$

S_1 can express this retraction by *okay (you may be right)*. This opens up a way for S_2 to assert φ and introduce φ, in the hope that S_1 will not object the second time around. In (19) we have analyzed *okay* as refraining from committing to the negation of the proposition, $\sim\cdot S_2 \vdash \neg\varphi$; in the present situation, this move presupposes the retraction in (24) and enforce it by accommodation. S_1 may even confirm φ, by asserting it: $[\cdot S_1 \vdash \neg\varphi \ ; \ \cdot\varphi]$, which also presupposes prior retraction of $S_1 \vdash \varphi$.

7 Compositional Interpretation

How do we get from an assertive sentence, like *It is raining*, to its interpretation? Recent proposals assume operators that turn the representation of the proposition into an update with the commitment for this proposition. Krifka (2015), cf. also Miyagawa (2022), has proposed an Act Phrase ActP with head "·" and a Commitment Phrase ComP with head "⊢" that takes a Tense Phrase TP as argument which denotes a proposition, resulting in the following interpretation (S_1, S_2 are speaker and addressee, respectively).

25. $[\![[_{\text{ActP}} \cdot [_{\text{ComP}} \vdash [_{\text{TP}} \textit{it is raining}]]]]\!]^{S_1,S_2}$
$= [\![\cdot]\!]^{S_1,S_2}([\![\vdash]\!]^{S_1,S_2}([\![[_{\text{TP}} \textit{it is raining}]]\!]^{S_1,S_2}))$
$= [\![\cdot]\!]^{S_1,S_2}(\lambda x[x \vdash \text{‘it is raining’}])$
$= \lambda C[C + \cdot S_1 \vdash \text{‘it is raining’}]$

The application of $[\![\vdash]\!]$ to a proposition results in a function from a person x to the proposition that x is committed to the proposition; the application of $[\![\cdot]\!]^{S_1,S_2}$ specifies x as the speaker, S_1, and turns the resulting proposition into a CS update.

However, (25) captures only the illocutionary act of assertion, not the perlocutionary act that puts the proposition into the CS, nor the disjunct that allows for rejection. In fact, it is not even possible to design a compositional interpretation that includes that perlocutionary effect, given the syntactic structure in (25), as the TP proposition is not accessible to $[\![\cdot]\!]$. One option is to assume that the TP introduces a propositional discourse referent, which is independently motivated by the interpretation of response particles like *yes* and *no* that take up such discourse referents (cf. Krifka 2013). This discourse referent is projected to the level of the ActP head "·", which can take it together with the TP and create the appropriate meaning. In the representation (26), the discourse referent of a proposition is realized as the first member of a pair with the TP meaning.

26. $[\![\cdot]\!]^{S_1,S_2}([\![\vdash]\!]^{S_1,S_2}(\langle\varphi, \varphi\rangle))$
$= [\![\cdot]\!]^{S_1,S_2}(\langle\varphi, \lambda x[x \vdash \varphi]\rangle)$
$= \lambda C[C + [\cdot S_1 \vdash \varphi \ ; [\cdot\varphi \vee \cdot S_2 \dashv \varphi]]$

In (26) the intended perlocutionnary effect $\cdot\varphi$ and its alternative $\cdot S_2 \dashv \varphi$ are built into the interpretation of "·". We may doubt that this effect is indeed part of the grammatical meaning: There are assertions that do not intend to inform, but only to commit (e.g. in a confession of religious faith). Alternatively, the continuation $[\cdot\varphi \vee \cdot S_2 \dashv \varphi]$ can be seen as a consequence of a pragmatic rule that is triggered by the introduction of a commitment to a proposition φ, with S_2 as the addressee. Then (25) represents the grammatical meaning of assertions.

8 Polar Questions

Leaving the topic of assertions we turn to questions. In a question, the speaker does not change the factual information present in the CS but indicates that the CS should take a certain development – in the most typical case, that the addressee asserts a proposition that answers the question. Hence questions have been modeled as sets of propositions in one way or other (Hamblin 1973, Groenendijk & Stokhof 1984, von Stechow 1990, Ciardelli et al. 2019). In the commitment space framework, questions are updates that leave the root intact but restrict the continuations (Krifka 2015). This allows to represent **question bias** in a straightforward way.

A simple polar question like *Is the door open?* is typically represented as a set $\{\varphi, \neg\varphi\}$, cf. Hamblin (1973). However, such questions can express a bias towards one proposition. The question *Is the door closed?* differs in this respect from *Is the door open?* (cf. Büring & Gunlogson 2000, Trinh 2014). The commitment space framework offers a way to express this bias by having such questions project only one proposition. Krifka (2015, 2022) implements this in a way that such questions create only one continuation with a commitment by the addressee to the proposition. Here I assume a refined model that incorporates reactions against the bias of the question as an alternative:

27. $[\![[_{\text{ActP}}\ ?\ \textit{is}\ [_{\text{ComP}} \vdash [_{\text{TP}}\ \textit{it \_ raining}]]]]\!]^{S_1,S_2}$
$= [\![?]\!]^{S_1,S_2}([\![\vdash]\!]^{S_1,S_2}([\![[_{\text{TP}}\ \textit{it is raining}]]\!]^{S_1,S_2}))$
$= [\![?]\!]^{S_1,S_2}\ (\lambda x[x\vdash\varphi])$
$= ?[\cdot[\lambda x[x\vdash\varphi](S_2)] \vee \cdot[\lambda x[x\dashv\varphi](S_2)]]$
$= \lambda C[\surd C \cup [\cdot S_2\vdash\varphi \vee \cdot S_2\dashv\varphi](C)]]$
$= \lambda C[\surd C \cup C + \cdot S_2\vdash\varphi \cup C + \cdot S_2\dashv\varphi]$

Questions have an ActP head ? to which finite copulas and auxiliaries move in standard polar questions in English. This head is interpreted by the restriction operator ?, cf. (14), that is applied to the CS update with the proposition that the **addressee**, here S_2, is committed to the TP proposition, $S_2\vdash\varphi$, disjoined with the announcement of doubt, $S_2\dashv\varphi$). The first continuation is the commitment by S_2 to the proposition φ; this represents the bias of the question. The other continuation consists in an update that the speaker doubts φ; this allows for responses like *no* or *I don't know*. As with assertions, the second part may be a pragmatic effect: When speaker S_1 checks if addressee S_2 would commit to φ, S_1 expects that S_2 expresses doubts about φ if S_2 does not want to commit to φ.

Let us consider the effect of different answers. Take C_7 as a CS that becomes updated by the question (27):

28. $(27)(C_7)$
$= [\surd C_7 \cup [\cdot S_2\vdash\varphi \vee \cdot S_2\dashv\varphi](C_7)]$
$= [\surd C_7 \cup C_7 + \cdot S_2\vdash\varphi \cup C_7 + \cdot S_2\dashv\varphi]]$
$= C_8$

In a **confirming** response, S_2 asserts φ to S_1. As with assertions, with *yes* S_2 picks up the TP proposition, commits to it, and proposes to accept it. The result is an update of the commitment space C_8 with the commitment of S_2 to φ, eliminating the second disjunct in (28), followed by an update with φ. This may be disjoined with an update with $S_1\dashv\varphi$, but as S_1 gave epistemic authority to S_2 this latter update is hypothetical.

29. $C_8 + [\cdot S_2\vdash\varphi\ ;\ [\cdot\varphi\ (\vee\ \cdot S_1\dashv\varphi])]$
$= C_7 + \cdot S_2\vdash\varphi + [\cdot\varphi\ (\vee\ \cdot S_1\dashv\varphi)]$

In a **dissenting** response, S_2 reacts with *no*, asserting the negated proposition $\neg\varphi$. Now the first disjunct of (28) gets eliminated, resulting in a commitment by S_2 to $\neg\varphi$ and two possible continuations, acceptance of $\neg\varphi$ or assertion of $\neg\neg\varphi$, $= \varphi$.

30. $C_8 + [\cdot[S_2\vdash\neg\varphi]\ ;\ [\cdot\neg\varphi\ (\vee\ \cdot S_1\dashv\neg\varphi)]]$
$= C_7 + \cdot S_2\dashv\varphi + \cdot S_2\vdash\neg\varphi + [\cdot\neg\varphi\ (\vee\ \cdot S_1\vdash\varphi)]$

Different from Krifka (2015), answers that go against the bias of a question do not require a retraction. There is still a difference to answers that go along with the bias, as they can be achieved by the reaction *yes* that does not require a negation. In case the question is based on a negated proposition, as in *Is it not raining?*, the answer *no* has an assenting reading as it may pick up the non-negated antecedent proposition, cf. Krifka (2013).

Responses like *I don't know* that express **inability to answer** can be dealt with as well as they are not compatible with $S_2\vdash\varphi$. but with $S_2\dashv\varphi$. Representing this proposition 'S_2 knows φ' as $K_{S_2}\varphi$, (which entails $B_{S_2}\varphi$) when uttered by S_2, we have to invoke the integrity constraint that rules out $S_2\vdash\varphi$ and $\neg K_{S_2}\varphi$. This is illustrated in (31). We treat the second disjunct $S_1\dashv\neg K_{S_2}\varphi$ as irrelvant, as S_1 has no epistemic authority over S_2's knowledge.

31. $C_8 + \cdot[S_2\vdash\neg K_{S_2}\varphi]\ ;\ [\cdot\neg K_{S_2}\varphi\ (\vee\ \cdot S_1\dashv\neg K_{S_2}\varphi)]$
$= C_7 + \cdot S_2\dashv\varphi + \cdot S_2\vdash\neg K_{S_2}\varphi + \cdot\neg K_{S_2}\varphi$

In case S_2 reacts with the assertion of an **irrelevant** proposition, such as *It's Monday.,* the effect is that the question still stays active, as both disjuncts of (28) can be updated with it. More specifically, such updates result in root multiplication:

32. $C_8 + [\cdot S_2\vdash\psi\ ;\ [\cdot\psi \vee \cdot S_1\vdash\neg\psi]]$
$= C_7 + \cdot S_2\vdash\varphi + \cdot S_2\vdash\psi + [\cdot\psi \vee \cdot S_1\vdash\neg\psi]$
$\cup\ C_7 + \cdot\neg S_2\vdash\varphi + \cdot S_2\vdash\psi + [\cdot\psi \vee \cdot S_1\vdash\neg\psi]$

9 Other Questions

We have dealt with simple polar questions, called **monopolar** by Krifka (2015), as they put one proposition in the foreground. **Alternative questions** such as *Is it raining or not?* and *Is it raining or snowing?* are disjunctions of such questions:

33. $[\![[[_{\text{ActP}}\ ?\ \textit{is}\ [_{\text{ComP}} \vdash [_{\text{TP}}\ \textit{it \_ raining}]]]\ \textit{or}$
$[_{\text{ActP}}\ ?\ \textit{is}\ [_{\text{ComP}} \vdash [_{\text{TP}}\ \textit{it \_ not raining}]]]]]\!]^{S_1,S_2}$
$= [?\cdot S_2\vdash\varphi \vee ?\cdot S_2\vdash\neg\varphi]$
$= \lambda C[\surd C \cup [\cdot S_2\vdash\varphi \vee \cdot S_2\dashv\varphi \vee$
$\cdot S_2\vdash\neg\varphi \vee \cdot S_2\dashv\neg\varphi](C)]$

The difference to the monopolar question (27) is that the update $\cdot S_2\vdash\neg\varphi$ is mentioned explicitly, and also introduces a propositional discourse referent. Hence this question is **non-biased**, with the answers *Yes, it is* and *No, it isn't* equally prominent.

Biezma (2009) observes that alternative questions based on a proposition and its negation come with a **cornering effect**: The addressee is forced to give a non-evasive answer. This can be derived from (33) under a preference for strongest disjunctive alternatives. Observe that $\cdot S_2 \vdash \varphi$ is stronger than $\cdot S_2 \dashv \neg\varphi$, in the sense that whenever a CS is updated with the former, the latter update does not add new information, due to the integrity constraint of commitment consistency that rules out $x \vdash \varphi$ and $x \dashv \varphi$. In the same way, $\cdot S_2 \vdash \neg\varphi$ is stronger than $S_2 \dashv \varphi$. This preference strengthens (33) to $\lambda C[\surd C \cup [\cdot S_2 \vdash \varphi \vee \cdot S_2 \vdash \neg\varphi]]$, which does not leave S_2 an option to evade the question.

Constituent questions like *When did it rain?* can be analyzed as generalized disjunction over the alternatives provided by the *wh*-constituent:

34. $[\![[_{ActP}$ *when* ? *did* $[\vdash [_{TP}$ *it* _ *rain* _ $]]]]\!]^{S_1,S_2}$
$= \bigvee_{t \in TIME} [?\cdot S_2 \vdash \varphi[t] \vee ?\cdot S_2 \dashv \varphi[t]]$

Possible answers specify one or more of the disjuncts, e.g. *It rained at noon*, or *It rained at noon and in the evening*, or *It rained at noon or in the evening.* Also, answers like *It did not rain at noon* (which implies $\neg S_2 \vdash \varphi[\text{noon}]$) can be handled. Answers to constituent questions typically are understood as exhaustive, which can be modeled by focus-induced alternatives in the answer, such as *It rained at* [*NOON*]$_F$ (cf. Kamali & Krifka 2020 for a proposal within the CS model).

Modeling assertions as in (17) or (26) with the help of a disjunction of the intended enrichment of the CS with the proposition φ and a commitment to its negation looks similar to an **assertion with question tag**, as in *It is raining, isn't it?* However, such cases can be transparently interpreted as a disjunction of an assertion with a question (cf. Krifka 2015, 2022). This disjunction can be expressed overtly, as e.g. in *It is raining, or not?*

35. $[\![[[_{ActP} \cdot [_{ComP} \vdash [_{TP}$ *It is raining*$]]]$
$[_{ActP}$? *is* $[_{ComP} \vdash [_{NegP}$ *n't* [*it* _ ~~*raining*~~$]]]]]]\!]^{S_1,S_2}$
$= \lambda C[\cdot S_1 \vdash \varphi\, ;\, [\cdot \varphi \vee \cdot S_2 \dashv \varphi]](C) \vee$
$[\surd C \cup [\cdot S_2 \vdash \neg\varphi \vee \cdot S_2 \dashv \neg\varphi]](C)]$

In this move, the speaker S_1 vouches for the truth of φ, trying to introduce φ, or alternatively, the addressee vouches for the truth of ¬φ. As the second part is a question, the root does not change in this overall move. In case S_2 confirms with *yes*, both S_1 and S_2 vouch for φ, and φ gets established. In case S_2 rejects with *no*, then S_1 is not committed to φ due to the second disjunct in (35). This differs from the plain assertion, *It is raining*, where the speaker commitment to the proposition remains even if the other speaker rejects this move with *no*. In a sense, question tags like the one in (35) have the effect that the speaker is committed to the proposition only under the condition that the addressee does not disagree.

10 Greetings

Having discussed assertions and questions, we turn to the classical adjacency pair of greetings. What is a greeting, as a speech act? In general, it is an acknowledgement of the presence of another person or group of persons, making them participants of the conversation. Particular greetings often incorporate the time of the day, express emotional involvement, and confirm the social relation between speaker and addressee as being familiar, distant, symmetric, or asymmetric. Greetings may be pure recognitions, such as *Hi!*, they may be derived from wishes as in *Good morning!*, or be based on questions about the current state of the other person such as *How are you?* (cf. Jucker 2017). There are non-linguistic greetings such as waving, eyebrow raises and whistles, and greetings are similar to callings (vocatives).

For the current purpose it is sufficient to assume a proposition λi[x greets y in i], in short G(x,y), which holds if x recognizes y. Adding this proposition to the CS presupposes that x is a participant, and makes y a participant as well. Example:

36. $[\![Hi!]\!]^{S_1,S_2} = \cdot G(S_1,S_2)$

This does not involve any commitment operator ⊢ as the speaker does not commit to the truth of the proposition $G(S_1,S_2)$ but simply creates it in the CS. This is similar to explicit performative speech acts like *I hereby open the buffet* or *The buffet is hereby open*, which also do not communicate about the world with the help of truth commitments but create new facts in the world (cf. Searle 1976, Szabolcsi 1982)

Greetings expect a counter-greeting, which ensures that the greeting was recognized. This expectation can be modeled by the restriction operator ?:

37. $C_9 + [\![Hi!]\!]^{S_1,S_2} = C_9 + \cdot G(S_1,S_2)\, ;\, ?\cdot G(S_2,S_1)$
$= C_{10}$

Here, the input CS is first modified by the greeting of S_2 by S_1, and then the greeting of S_1 by S_2 is established as the preferred continuation. If S_2 greets back, the conversation goes on smoothly:

38. $C_{10} + [\![Hi!]\!]^{S_2,S_1} = C_9 + \cdot G(S_1,S_2) \,;\, \cdot G(S_2,S_1)$

But what happens if S_2 does not recognize S_1? Then the effect of S_1's greeting obviously does not obtain. This can be modeled by assuming a disjunction between the effect of the countergreeting, and the **removal** of the effect of the first greeting:

39. $[\![Hi!]\!]^{S_1,S_2} \cdot[G(S_1,S_2) \,;$
$[?\cdot G(S_2,S_1) \vee -G(S_1,S_2)]]$

Again, if S_2 greets back, the conversation goes on as intended. If S_2 fails to do so, the effect of the first greeting is removed, that is, it is not part of the CG that S_1 recognized S_2. In this situation, S_1 can greet S_2 again in a second attempt to enrich the CG by mutual recognition.

In the case of assertions, the opt-out move was not specified as a removal of the commitment of the first speaker, $S_1 \vdash \varphi$. The reason for this is that the commitment of the speaker remains even if the speaker's move is not taken up.

11 Offers and Commands

The final interactional pair we consider are offers (commissives), in which the speaker promises to do something, such as *I promise to do the dishes*, and commands (directives), in which the speaker obliges the addressee to do something, such as *Do the dishes!* They differ from assertions about future actions or deontic propositions (*I will do / you must do the dishes*), insofar the speaker does not commit to a proposition that is independently true of the utterance itself.

However, these future clauses can also be used as performatives (optionally marked by *hereby*). This provides a novel way of modeling offers and commands as performative speech acts that add propositions about future actions. This is different from the analysis of imperatives as performative deontics in Kaufmann (2012) but related to the analysis by Barker (2011) as imposing future actions. The addressee has an option to decline the offer or to reject the command, which again can be expressed by a disjunction. Let WD(x) be the proposition 'x will do the dishes':

40. $[\![\textit{I promise to do the dishes}]\!]^{S_1,S_2}$
$= \cdot WD(S_1) \,;\, [?\cdot S_2 \vdash WD(S_1) \vee -WD(S_1)]$

41. $[\![\textit{Do the dishes!}]\!]^{S_1,S_2}$
$= \cdot WD(S_2) \,;\, [?\cdot S_2 \vdash WD(S_2) \vee -WD(S_2)]$

In (40) the speaker S_1 introduces the proposition that S_1 will do the dishes but this depends on confirmation by S_2, here rendered as an assertion; otherwise the proposition is removed. The situation is similar in (41) except that now S_1 places an obligation on the addressee S_2 that can be confirmed or dismissed by S_2. For example, if S_2 reacts with *No*, asserting $S_2 \vdash \neg WD(S_2)$, this is only compatible with the second disjunct in (41). Both speech acts could be expressed by performatively interpreted future propositions, but there are idiomatized forms for commissives and grammaticalized forms for directives (cf. Gärtner 2020).

12 Conclusion

This paper developed an algebraic model that allows for the modeling of adjacency pairs in a framework of common ground update. It made use of the commitment space (CS) model that incorporates a forward-looking dimension in CG updates. The essential idea is that the possible reactions to a particular update are represented in these possible continuations. It is crucial that the commitment states that make up a CS satisfy pragmatic integrity constraints that restrict the possible moves.

There are a number of issues that this approach raises, some of which mentioned by the reviewers. One concerns the psychological plausibility, given modelling by infinite sets. Appendix 2 argues that a representational variant is possible that works with an interpreted language. Another is the fact that conversation often requires collaboration and the recognition of long-term intentions beyond mere adjacency pairs (Clark 1996). The CS model with its focus on continuation is actually a promising framework for such wider-reaching conversational plans. Another is the fact that conversations often interleave with real actions; this necessitates a notion of CSts and CSs that includes aspects of shared attention beyond language (cf. Clark 1997, Hunter et al. 2018). Finally there is the conception of CSs as a representation of the CG that is supposed to be shared. Participants may have different ideas about what the CG is, which may necessitate private versions of the CG such as the dialogue gameboards of Ginzburg (2012), but see Gregoromichelaki et al. (2020) in defense of a common space of interactions.

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Appendices

Integrity constraints

The theoretical approach presented here relies on integrity constraints for Commitment States (CSts) In particular, update c+φ results in c ∪ {φ} only if the integrity constraints are satisfied. These constraints represent rational communicative behavior that participants expect from each other in conversation. The constraints used in the text are listed here as combinations of propositions that are ruled out for well-behaved CSts, where x stands for a participant in conversation, P for sets of propositions, ⇒ for logical consequence, ⊢ for public commitment to the truth of a proposition and ⊣ for announcement of doubt to a proposition.

1. * $\varphi \in c, \exists P \subseteq c[P \Rightarrow \neg\varphi]$ logical consistency
2. * $x\vdash\varphi, x\vdash\neg\varphi \in c$ claim consistency
3. * $x\vdash\varphi, \neg\varphi \in c$ claim/proposition consistency
4. * $x\vdash\varphi, x\dashv\varphi \in c$ claim/doubt consistency
5. * $x\dashv\varphi, \varphi \in c$ doubt/proposition consistency
6. * $B_x\neg\varphi, \varphi \in c$ belief/proposition consistency
7. * $B_x\neg\varphi, x\vdash\varphi$ belief/claim consistency

The following two integrity constraint do not restrict commitment states but commitment spaces:

8. All commitment states in a commitment space satisfy the integrity constraints for commitment states.
9. If there is a $c \in C$, with $x\dashv\varphi \in c$, then there is a $c' \in c$ with $c \subseteq c'$ such that $x\vdash\neg\varphi \in c'$.

The latter states that if x commits do doubt about φ then x does not rule out to commit to ¬φ.

Representation of Commitment States / Spaces

The framework to conversation presented here follows Stalnaker's approach to Common Ground updates insofar as CGs were captured by propositions (sets of propositions for CSts, sets of sets of propositions for CSs). In this it is similar to frameworks such as Farkas & Bruce (2010) and Ciardelli et al. (2019). But relying on propositions as sets of world-time indices, and on sets (of sets) of such sets, may be psychologically and implementationally implausible (cf. Ginzburg 2012). But representational versions of the framework presented here can be developed that achieve a compact formulation of commitment spaces:

As for CSts, instead of being modelled by sets of **propositions** φ they can be represented by sets of **formulas** φ in an interpreted language that state the truth conditions of these propositions, $[\![\varphi]\!] = \varphi$.

As for CSs, instead of being modelled by sets of sets of propositions that represent possibly infinite continuations, a CSs C can be represented by the CSts in its root √C, potentially extended by one continuation level in the case of questions. We can derive C as the union of all expansions E(R) of a possibly extended root set R of CSts that satisfy the integrity constraints, if we add certain formulas.

10. $\cdot\varphi(R) = \{c \cup \{\varphi\} \mid c \in R\}$
    if integrity constraints are satisfied
11. $[?\varphi](R) = R \cup \cdot\varphi(R)$ restriction
12. $[A ; B](R) = B(A(R))$ dynamic conjunction
13. $[A \vee B](R) = A(R) \cup B(R)$ disjunction
14. $[\sim\varphi](R) = \{c \cup \{\sim\varphi\} \mid c \in R\}$ denegation

Denegation instructs expansion E not to include φ. This is mediated by an integrity constraint:

15. * $\sim\varphi,\ \varphi \in c$

In this blocking of φ, $\sim\varphi$ has a similar effect as negation $\neg\varphi$, but notice that $\sim\varphi$ is not interpreted: If $\sim\varphi \in c$ then c leaves it open whether φ holds or not; if $\neg\varphi \in c$ then c rules out that φ holds. Hence, retraction of $\sim\varphi$, as required by addition of φ, does not change the truth conditions of a CSt, and is a monotonic operation on this level.

The formulas $x\vdash\varphi$ and $x\dashv\varphi$ also have a blocking effect, on ¬φ. In this case, we can assume that the retraction of $x\dashv\varphi$ occurs no social costs to x, in contrast to the retraction of $x\dashv\varphi$.

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